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Fagus sylvatica. Beech (K).

TREES

A HANDBOOK OF FOREST-BOTANY FOR THE WOODLANDS AND THE LABORATORY

BY THE LATE

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Fellow of Sidney Sussex College, Hon. Fellow of Christ's College, and Professor of Botany in the University of Cambridge

VOLUME IV

FRUITS

WITH ILLUSTRATIONS

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EDITOR'S PREFACE

IN seeing this volume through the press my aim has been to leave it as much as possible the Author's own work. The contents have therefore been left undisturbed as regards matters of opinion and terminology: the few and slight alterations made have been such as the Author would certainly have approved, and are not indicated by any square brackets. Only for the facile task of selecting appropriate illustrations must I accept responsibility.

The Author intended to write three volumes in addition to those already published, but unhappily was not spared to complete his full scheme. He, however, left behind sufficient manuscript to make up two volumes. The present volume will, therefore, be succeeded by a final one, which is now in the press.

Certain delay has occurred in publishing the volume owing to the fact that when the task was first suggested to me I was deeply occupied with work which could not be laid aside.

The sources of certain illustrations are acknowledged as in the preceding volumes. Additional figures have been obtained from: *Baüme und Straücher des Waldes* by Hempel and Wilhelm (H and W); *Illustrirte Handbuch der Laubholzkunde* by Schneider; *Text-book of Botany* by Strasburger and others (Stras); *Natural History of Plants* by Baillon (Bai); *Botanik für Forstmänner* by Döbner and Nobbe; *Die Nadelhölzer* by von Tubeuf. To Messrs Hölzel, Gustav Fischer, Macmillan, Lovell Reeve & Co., P. Parey, and Ulmer, the respective publishers of these, thanks are due for courteous permission to publish the illustrations in question.

It is also a pleasure to thank Mrs Marshall Ward for compiling the Index.

PERCY GROOM.

October, 1908.

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PART I.

GENERAL.

CHAPTER I.

THE FRUIT.

Effects of Fertilisation—Definition of Fruit—True and False Fruits—Simple, Collective, and Aggregate Fruits—Dry and Fleshy Fruits—Dehiscent and Indehiscent Fruits—Inferior and Superior Fruits—Wall of the Fruit—Pericarp, Epicarp, Mesocarp, and Endocarp.

THE effects of pollination and fertilisation are by no means confined to the ovules and their contents, and it has long been observed that in some flowers (e.g. many orchids) the petals, &c. remain turgid and fresh for many days if the stigma is not pollinated, but wither at once when that act is accomplished. The most important secondary effects of fertilisation are usually those induced in the ovary, the walls of which increase and often become very thick and succulent, and the whole form of which may alter under the effects of the increased supplies of water and food-materials which now flow to the excited centres—for, that the centres are thus excited to exert a draught on the supplies seems proved by their behaviour when pollination fails, and the young ovaries shrivel. At the same time pollination need not always be successful, or perhaps even occur, for a fruit to ripen, as cultivated

varieties of seedless grapes, bananas, pineapples, &c., testify.

In many cases the changes in structure brought about are so striking that the walls of the fruit receive special names for their various parts, and fusions of different kinds and degrees occur with other organs. One consequence of these changes is a confusion between what is really fruit, and what is merely edible—a popular but very erroneous test for a fruit, as may be easily shown by examining an ordinary greengrocer's, seedsman's, or cook's definition of the words "fruit," "seed," and "vegetable." Such authorities would almost invariably call the seed-filled pods of Peas and Beans, and Cucumbers, "vegetables," and mulberries, strawberries, pineapples and figs, fruits; whereas they would almost certainly regard the little hard bodies in the fig or on the surface of the strawberry as "seeds," and would give the same name to the parts of the Caraway employed in flavouring "seed-cake," or to those parachute-like toys of our childhood which the wind carries off from the ripe heads of Dandelions and Thistles, though they are fruits; and seedsmen, gardeners and others habitually regard the fruits of Maize and grasses of all kinds, as well as of Oaks, Beech, Maples, Alders, &c. as "seeds."

These ideas, and many similar popular errors, however, require careful examination, with due regard to the proportion of truth they embody as well as strict criticism of the fallacies they propagate; and a correct appreciation of the real state of affairs will only be obtained by the student who observes for himself the various stages in the maturation of the fruit as the flower ages.

Strictly considered *the fruit is the ripened carpels with their enclosed seeds*; and its purpose after protecting the seeds is frequently extended to disseminating, or

promoting the dissemination of the seeds, in various ways. We have then to discriminate at the outset between *true* fruits and *false* fruits (*pseudocarps*), the latter being the true fruit with something added.

Again, adhering to our definition of a fruit as the matured carpels and their enclosures, it is obvious that a single specimen of a fruit is usually derived from the pistil of one flower—e.g. each Pea-flower produces *one* pod (compare Figs. 1, 5), each Plum-flower *one* plum and so on, and this whether the fruit so produced is true or false.

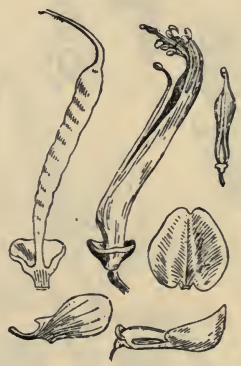


Fig. 1. Parts of the flower of a Robinia, including the single pistil.

But in many cases the "fruit" is found to be a composite product, derived by the agglomerated products of several flowers. A young mulberry (Fig. 2) is seen on examination to be a cluster (spike) of several female flowers, a young fig is lined by hundreds of small flowers, and a pineapple is composed of as many fruits, each the product of one flower, as there are rhomboid marks on its surface. Here, then, comes in a new distinction, between *Simple*

fruits and *Collective* fruits. *Benthamia fragifera* has thus a collective fruit, and *Sarcocephalus, Nauclea, Cephalanthus, Morinda* (Fig. 54) and other Rubiaceæ afford other examples.

Fig. 2. Mulberry, *Morus alba*. 1, a male, and 2, a female flowering shoot; 3, male, and 4, female flower, enlarged; 5, the latter in vertical section; 6, the multiple fruit (Wo).

Furthermore, it will be evident on examining and comparing the fruits and flowers of a Buttercup (Figs. 15, 16), a Peony, a Larkspur or a Marsh-marigold (*Caltha*, Fig. 3), &c., and comparing them with those of Poppy, Lily, Violet,

or Primrose, &c., that if we give the name of *a* fruit to each individual carpel of the former as it ripens (these flowers having *apocarpous* gynœcia) and also the name of *a* fruit to the whole mature *syncarpous* pistil of the latter, we are comparing parts with wholes, although in both cases the total fruit arises from a single flower. Here then is another point of distinction—the total aggregate of little separate fruits of a Buttercup, &c. forms an *aggregate* fruit (*œterio*), while the single but syncarpous fruit of a Poppy (Fig. 4), &c. counts as an individual fruit.

Fig. 3. *Caltha.*
Aggregate Fruit (Le M).

Fig. 4. *Papaver somniferum.*
Porous capsule, cut open (E and P).

It is obvious, therefore, that the student has some initial difficulties to overcome in determining the botanical nature of a fruit, and equally obvious that these difficulties can be overcome by observing and comparing. The best guides are undoubtedly the flowers with their as yet unripened fruits, side by side with the mature fruits; but as experience and practice increase the student soon learns to use other guides to aid him. For instance the lens will frequently show the shrivelled

styles or stigmas, or the scars whence they fell off; or it will show the remains of stamens, petals, sepals, &c.: while sections through and across the longitudinal axis give the clues as to positions, numbers, and separation or union of the carpels, and their relations to the axis, which decide the points in question. As in all cases the real starting point is to know what kind of questions to ask Nature, and how to proceed to obtain the answers.

One very evident feature in fruits of all kinds is their consistency. Many fruits are *dry* when ripe—e.g. Poppy, Pea (Fig. 5), acorn, Wheat, &c.; whereas it is equally striking that others—e.g. Plum, Apple, Gooseberry, Grape, &c.—are *fleshy* or succulent, and a very useful character in distinguishing and describing the various kinds is thus afforded. Moreover, we notice that whereas fleshy fruits do not open in any definite manner to allow the seeds to escape, dry

Fig. 5. Pea, dehiscent fruit, a legume (Le M).

fruits often do so open, or *dehisce*. For instance those of the Pea and Poppy obviously dehisce, the former by splitting down the back and front, the latter by pores

near its apex; but the acorn and Wheat-grain are *indehiscent*—which is one reason why people so often regard them as seeds, though a glance through the lens shows the stigmas or their scars at their tips.

Another excellent character for determining fruits exists in their positions as regards the stamens, petals, &c. Contrast the fruits of an Apple (Fig. 6, *A*), an Iris and a Gooseberry, with those of an Orange, Lily, and a Cherry or Blackthorn, for instance. In the former the scars or remains of sepals, petals, stamens and style can be seen with a lens at the apex of each fruit—clearly the fruit

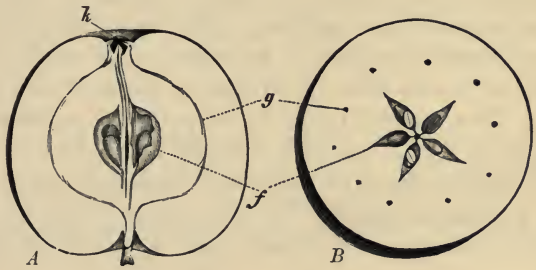


Fig. 6. Apple, inferior fruit. *A*, cut lengthwise and showing the epigynous calyx (*k*); *B*, cut transversely (E and P).

is *inferior*, a point rendered still more decided if their flowers and ovaries are compared side by side with the fruits: in the latter, however, we may find the scar or remains of the style at the apex, but those of the stamens, petals, &c. are at the base, next the stalk—clearly these fruits are *superior*, and we shall find that these relations of position (in the main those of the gynœcium in each case) are valuable aids to determining fruits, as they are in distinguishing ovaries.

One more point. The walls of the carpels or ovary composed of carpels, frequently undergo great changes in

thickness, consistency and even structure, as the fruit ripens, and these alterations commonly invade parts not belonging to the ovary, but fusing with it in the fruit. Consequently the walls of the fruit receive their special terminology, best understood by considering a true fleshy fruit like the plum or cherry. The whole fruit-wall is termed the *Pericarp*, and this is marked out into three regions—an outer thin skin, the *Epicarp*, an inner bony wall (the stone) or *Endocarp*, and the fleshy portion between, the *Mesocarp*. That the stone here is really part of the pericarp is easily shown by the attachment of the seed (kernel) inside, as well as by comparison with very young plums or cherries. The terms 'pericarp' and its subdivisions are not to be looked upon as strict morphological equivalents of particular parts of the ovary-walls: they mark, rather, convenient "geographical" areas, so to speak, and are comparable to such areas as pith, wood, and bark as commonly distinguished in transverse sections of stems. They are simply convenient as expressing demarcated regions really visible in such fruits.

CHAPTER II.

CLASSIFICATION OF FRUITS.

Dehiscent Dry Fruits—Follicle—Legume—Silique—Capsules and their Dehiscence—Indehiscent Dry Fruits—Nut—Achene—Caryopsis—Cypsela—Samara—Schizocarps—Fleshy Fruits—Drupe—Berry.

WITH the above general principles at command, we can now proceed to a review of the more important kinds of fruits, illustrating their other characters as we go.

An astoundingly large number of plants have fruits of the following simple type.

A single carpel, superior, and free, ripens directly into the fruit. In many cases the pericarp remains thin and dry, and forms a pod-shaped *Follicle*, opening by one

Fig. 7. *Aconitum Napellus*, æterio of three follicles (Bai).

suture only and allowing its several seeds to escape. Curiously, follicles rarely occur isolated (some species of *Delphinium*, Connaraceæ, Proteaceæ, &c.), but in groups of three to many (*œterios*) they are common in Ranunculaceæ (Peony, Columbine, Larkspur, *Aconitum* (Fig. 7), &c.), Magnoliaceæ (*Illicium*, *Magnolia*, &c.), Crassulaceæ (*Sempervivum*), &c. The rule is that follicles dehisce by the ventral suture, where the seeds are borne (Figs. 3 and 7): in *Magnolia*, however, they split down the dorsal suture (Fig. 42).

In Asclepiadaceæ, Sterculiaceæ and some other cases, we have a syncarpous ovary separating into its constituent carpels, which become follicles, as the fruit matures.

When the fruit has the same characters as the follicle, but splits down *both* sutures, it is termed a *Legume* (Fig. 5), and this again is a common and wide-spread type especially characteristic of the natural order Leguminosæ (Peas, Beans, Vetches, &c.).

Fig. 8. Wall-flower, silique (Bai).

In the Cruciferæ there prevails a type of fruit which at first sight looks like a pod, and without examination may be confounded with a Legume. It opens by two valves, but leaves the placentæ and seeds behind attached to the two sides of a sort of frame, across which a thin partition-membrane is stretched. The distinctive point is that each valve is the dorsal and greater portion of a carpel, and the frame the united edges of the two carpels, the membrane being a false septum stretched between them. This fruit is known as a *Silique* (Fig. 8).

The above three types of fruit agree in being dry and dehiscent, and shedding the seeds from the cavity; but

the Silique differs from the other two in being syncarpous. Now suppose three or more carpels to be united into a syncarpous fruit, and the pericarp dry and shedding the loosely boxed seeds by dehiscence. This gives a general type of box-like fruit known as the *Capsule*, very common and very various in details. The capsule may be of various shapes, long and pod-like (*Epilobium*, *Moringia*, &c.), globose (Pimpernel, Poppy), cordate (*Veronica*, *Polygala*), &c.: it may be one-chambered (Violet, Primrose) or incompletely divided up into several chambers (Poppy, *Viscaria*, &c.) or with several chambers (*pluri-locular*) as in Lilies, *Datura*, &c.; and the relation of this

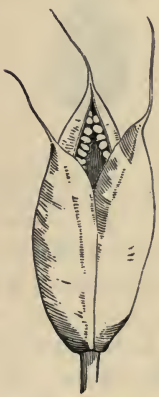


Fig. 9. *Colchicum*, septicidal capsule (Le M).

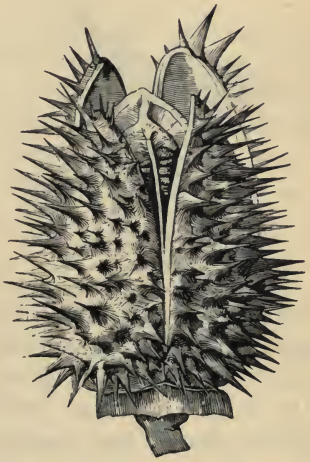


Fig. 10. *Datura*, septifragal capsule (Le M).

to the placentation is obvious when the origin from the gynœcium is understood—in unilocular capsules the placentæ are *parietal*, *free-central*, or, when incompletely

plurilocular, they may be *septal* (Poppy); in plurilocular capsules the placentæ are *axile* as a rule.

Another important point about the capsule is its mode of dehiscence. In most cases the splitting occurs longitudinally, either down the sutures where the placentiferous margins of the carpels cohere (*septicidal*), when the valves represent the carpellary leaves and usually bring the placentæ away at their margins (*Colchicum*, Fig. 9); or the dehiscence is down the middle of the dorsal suture (mid-rib) of each carpel (*loculicidal*), when the valves represent two half-carpels each and generally bring the placentæ away down their centres (Violet, Fig. 11); or, finally, such splitting may be accompanied by a

Fig. 11. Pansy, loculicidal, one-chambered capsule (Le M).

Fig. 12. *Lychnis*, capsule dehiscing by teeth (Le M).

splitting down the septa themselves (*septifragal*) as in *Datura* (Fig. 10), &c., and in these cases the placentæ are usually left behind on the axis.

In much rarer cases the dehiscence is transverse, so that the top of the capsule lifts off like a lid, as in Pimpernel, *Lecythis*, Plantain, Henbane, Purslane: such a capsule is termed a *Pyxis* (compare Figs. 48, 49).

In other cases the dehiscence is less complete than in the above, and mere tooth-like valves—the tops of the carpels—separate above as teeth (Fig. 12), the number of which differs for the species, &c. (e.g. *Lychnis*, Primrose).

Finally, in Poppies, *Campanula*, and a few others the seeds escape through definite apertures in the capsule walls (*porous* dehiscence), and the pores vary in position, shape, and the degree in which they most closely resemble slits, rounded holes, or valvular openings (Fig. 4).

There is yet another point of importance in describing capsules. Some, as those of the Poppy, Lychnis, and most of the examples given above are *superior*, whereas in *Campanula*, *Iris*, *Colchicum*, orchids and many others they are *inferior*. Intermediate positions also occur.

In all the above types of capsular fruits—for it is obvious that the *Follicle*, *Legume* and *Silique* come under the general heading—the faculty of dehiscence is prominent and the seeds escape.

In many cases, however, the ripe fruit only contains *one* seed (or more rarely two) and does not dehisce, and so common are such fruits that they receive special names. The principal characteristic of them all is that the seed (or embryo on germination) only escapes by the rotting or irregular breaking of the usually hardened and never fleshy pericarp. They may be brought under the general name of *Nut* or *Nutlet*.

Strictly speaking the *Nut* is a permanently closed, syncarpous fruit, one-seeded by abortion, and with a hard pericarp or shell, as acorns, Beech-nut, Hazel-nut, &c., and in these typical cases there is an investing *cupule*, more or less prominent, around them.

Two popular errors in relation to the meaning of the word "Nut" have to be noted. Owing to the hard "shell," objects such as the kernels of cherries, plums, coco-nuts and so on, often receive the name though their real nature is different; and owing to the "shell" being not obviously different from a seed-coat, nuts like the acorn, Beech-mast, &c. are frequently confounded with seeds, though

Fig. 13. Hazel, *Corylus Avellana*. 1, twig with ♂ and ♀ flowers; 2, leaf and nearly ripe fruits; 3, scale, bearing ♂ flower; 4, a stamen; 5, female flower invested by the young involucre; 6, sections through ovary; 7, 8, nuts; 9, 10, kernel (embryo) (Wi).

the remains of the stigmas above show them to be fruits. The student can test this latter character easily by comparing the sweet-chestnut (a nut) with the horse-chestnut

Fig. 14. Chestnut, *Castanea vesca*. 1, flowering shoot; 2, vertical section through cluster of female flowers in their involucre; 3, transverse section of ovary; 4, a male flower; 5, fruits in their involucre (Wo).

(a seed), the prickly covering of the former being a *cupule* and each chestnut having its withered stigmas above, whereas in the horse-chestnut the prickly covering is the true pericarp.

A still commoner form of the Nut-type is the *Achene*, which is normally a monocarpous, one-seeded, and usually

small, indehiscent fruit, but may be syncarpous; it is very generally confounded with a "seed" by the tyro. Good examples of achenes occur in Buttercup (Figs. 15, 16),

Fig. 15. *Ranunculus arvensis*, æterio of achenes (Bai).

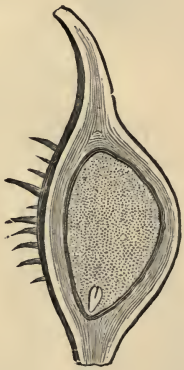


Fig. 16. *Ibid.*, single achene cut down the middle (Bai).

Potentilla, Anemone, &c.—in each case there is an æterio of achenes—Strawberry—also having an æterio, but with the torus fleshy—and in the Rose-hip (Fig. 17), where the achenes are sunk in the fleshy receptacle. In the Fig also, the little hard seed-like bodies are the true fruits, achenes, each in this case being the product of a single flower (Fig. 68).

In grasses—e.g. Wheat, Barley, Maize, &c.—the coats of the achene are so closely fused with those of the true seed inside, that there is more excuse for the popular idea that such grains are seeds, and the fruit is termed a *Caryopsis.* In this case it should be noted that the closely investing coat is often something more than the pericarp, the husks often consisting of the chaff-scales (glumes, &c.) as well—e.g. Rice, Barley, *Coix*, &c.

In the cases quoted the achenes are superior fruits, but in Compositæ (Dandelion, Sunflower, Thistle, &c.)

Fig. 17. Dog Rose, *Rosa canina*. 1, flowering shoot; 2, flower in vertical section; 3, the hip, and 4, the true fruit; 5, the latter in section; 6, floral diagram (Wo).

the achene-like fruit is obviously inferior, and this class of inferior achenes is termed a *Cypsela*.

It is a very common event that an achene-like fruit has the pericarp prolonged at one end (Ash (Fig. 18), *Machærium*, &c.), or at one side (species of *Ferreirea*, *Pterocarpus*, *Platypodium*, &c., Fig. 18), or at both ends (*Ailanthus*, Fig. 19), or all round (*Pterocarpus santalinus*, Elm, Birch, &c.), into a thin membranous wing, and such a fruit is

Fig. 18. Ash, *Fraxinus excelsior*. 1, flowering dwarf shoots with hermaphrodite flowers; 2, female inflorescence; 3, 4 and 5, hermaphrodite flowers; 6, male flower; 7, ovary; 8 and 9, ovary in vertical and transverse section; 10, winter twig with fruits; 11, seed in section; 12, seed torn open; 13, seedling (Wi).

termed a *Samara* (Figs. 31, 66). The wings are adapted for distribution by the wind.

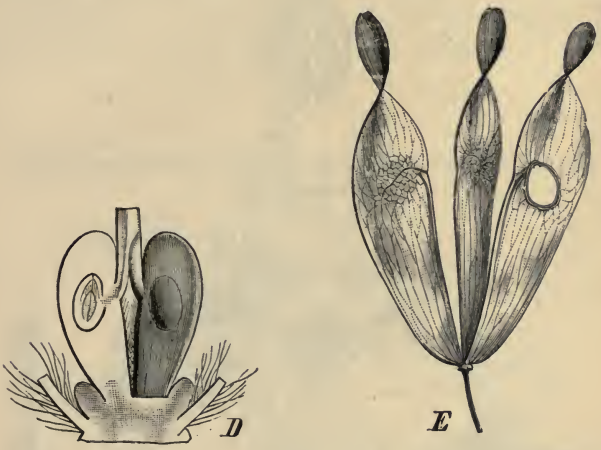


Fig. 19. *Ailanthus glandulosa*, Tree of Heaven. *D*, vertical section of ovary, disc and base of stamens; *E*, fruit with three ripe carpels, one in section through the seed (E and P).

In the Umbelliferæ, *Malva*, and some others we find a type of dry fruit, composed of two or more carpels, where the carpels separate at maturity from the floral axis, but do not dehisce, and so have a resemblance to achenes, and like them are often confounded with seeds. The whole fruit is a *Schizocarp*; and each carpel thus separated is called a *Mericarp*, and it frequently remains attached by a slender process of its walls for some time to the floral axis or its prolongation (*carpophore*) until completely detached by the wind or otherwise.

In the Geraniaceæ the mericarps and carpophore are prolonged as the characteristic beak, whence the names "Crane's-bills," "Stork's-bills" applied to these fruits. In *Malva* the mericarps separate at once. In the Maples

(Fig. 21) the mericarps are "winged" (samaroid). In the Umbelliferæ (Fig. 20) the Schizocarp is inferior, and is

Fig. 20. *Aethusa* (Umbelliferæ), cremocarp separating into two mericarps (Le M).

Fig. 21. Maple, *Acer campestre*. 1, flowering shoot; 2, male flower; 3, ovary and stamens on the glandular disc; 4, ovary; 5, fruit; 6, buds (Wi).

often termed a *Cremocarp*; but in the others mentioned above it is superior.

The above will suffice as types of dry fruits, dehiscent and indehiscent. It now remains to examine the principal types of fleshy fruits, in which the carpellary walls or

Fig. 22. Cherry, *Prunus Cerasus*. 1, flowering shoot; 2, leaf; 3, bud-scales; 4, 5, flower in vertical section; 6, fruit (Wo).

other investing coverings obtain a succulent mesocarp, owing to the filling of their cells with sap of a sweet or otherwise attractive character, which induces animals to eat and disperse them. In correlation with this such fruits are as a rule indehiscent, and the seeds protected

Fig. 23. Walnut, *Juglans regia*. 1, flowering shoot, bearing *a* a male catkin and *b* a female inflorescence; 2, male flower with *a* a stamen seen from within, *b* one from the side; 3, female flower; 4, vertical section of same; 5, fruit with one half removed; 6, vertical section through the nut; 2, 3 and 4 enlarged (Wo).

by hard coats or investments calculated to protect them against the action of the gastric juices.

The simplest type is the *Drupe*, or Stone-fruit, as found in the Cherry (Fig. 22), Plum, Peach, &c., where it arises from a single carpel, the inner wall (endocarp) of which forms the "stone," around the seed. Many fruits, however, are termed drupaceous which arise from syncarpous ovaries, the bony or stony endocarp being the principal criterion—e.g. *Spondias*, *Celtis*, Olive, and Coffee, &c., where there are often two or more seeds, and the Walnut (Fig. 23), Almond, &c., where the mesocarp is not really fleshy but rather spongy or leathery, while in the Cocoanut the mesocarp is fibrous. The above examples show clearly that the types of fruits are not to be taken as strictly definable morphological types, but as more or less indications of resemblances to an arbitrarily selected type in each case. In the Bramble (Fig. 24), Raspberry, *Quassia*, &c. we have an æterio of *Drupels*—each succulent pip being a true drupe. The mulberry (Fig. 2) *looks* very similar, but in this case each succulent pip (*Drupel*) is the product of a separate flower, the fleshy part being mainly the swollen perianth.

The *Berry* is another extremely common type of fruit, and comprises all fruits in which the endocarp as well as the mesocarp is succulent, e.g. Barberry, *Arum*, Grape, Currant, Gooseberry, Cranberry, Tomato, Melon, Cucumber, Banana, &c. The Latin name being *Bacca*, berry-like fruits are termed *Baccate*, and some distinctions must be noticed between some of the above examples.

Thus, the Barberry, Grape and Tomato come from a superior ovary, whereas the Currant, Gooseberry, &c. are inferior. Again the Barberry and *Arum* are monocarpous, but the others are syncarpous. Berries as a rule contain several seeds, but in the Date there is only one;

the hard stone, which is here the true *seed*, must be carefully distinguished from the stone of a *Drupe*, which is the bony endocarp enclosing the seed.

The fruit of the Melons, Cucumbers, Gourds, &c. is often termed a *Pepo*, but although the firmness of the epicarp is insisted on, it is, as is also the Pomegranate, really a Berry. In the same way the superior Berry of the Orange, edible Lime, Lemon, &c. is often called a *Hesperidium*, while the inferior one of the Apples, Pears, &c. is termed a *Pome* (Fig. 6).

Fig. 24. Blackberry, *Rubus fruticosus*. 1, flowering shoot; 2, vertical section of flower, slightly enlarged; 3, fruit, reduced; 4, floral diagram (Wo).

The foregoing will suffice to show the student the principal types of fruits and at the same time how complex fruits may be, and the impossibility of defining them in all cases. The fact that many fruits partake of the characters of more than one type is alone sufficient to render the task of classifying them exhaustively well nigh impossible.

The only way to really understand the various types of fruits is to trace their origin from the pistil, and their transitional forms in closely allied plants and groups of plants.

CHAPTER III.

FRUITS OF LEGUMINOSÆ, AND ROSACEÆ.

Fruits of Leguminosæ—Legume—Dehiscent and Indehiscent Fruits —Lomentum—Twisted Fruits—Fleshy Fruits—Longitudinal Septa — *Entada* — Achene — Samara — Drupe — Subterranean Fruits. Fruits of Rosaceæ—Follicle—Capsule—Legume—Achene—Drupe—False Fruits—Aeterio of Achenes or Drupes —Inferior Fruits.

THE student can obtain an excellent insight into the relations of monocarpellary fruits by comparing the play of forms observed in a large family such as the Leguminosæ.

The type is the many-seeded, normal legume (Fig. 5) which gives the name to the family. It opens as two flat or curled membranous, or rarely (e.g. Lupin) more or less fleshy, valves, and is inflated in the tribe Colutinæ (Fig. 25) and some species of *Astragalus*; but in *Batesia* only one suture opens and the fruit becomes a *Follicle*, while in some Colutinæ the two valves only gape above. One of the commonest departures is that the legume does not dehisce by the sutures, but is either simply indehiscent (*Arachis*, Dalbergiæ and many Cæsalpiniaceæ); or, more often becomes septate by the formation of cross-partitions between the seeds, and is then indehiscent (*Cassia* (Fig. 26), *Sophora, Cathartocarpus*, &c.) or breaks

at the septa into 1-seeded pieces (*Ornithopus, Coronilla, Hippocrepis, Desmodium, Hedysarum,* &c.). This last form is called a *Lomentum.*

Fig. 25. *Colutea arborescens*, L. *A*, shoot with flowers and inflated pods. *B*, pistil. *C*, transverse section of pod (E and P).

In *Medicago* (Lucerne, &c.) we find the pod curved round like a sickle, or twisted up into a helix or spiral, and dehiscing only slightly or not at all; and in this genus

many varieties of such spirally twisted forms are met with (Fig. 27). In *Prosopis* the fruit looks like a curl.

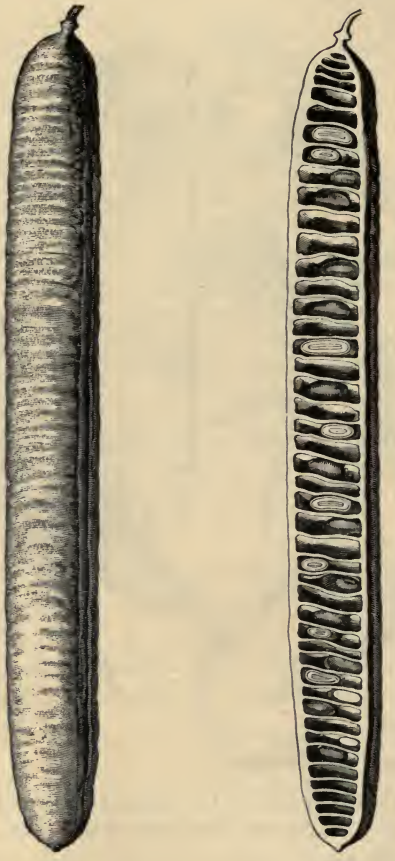


Fig. 26. *Cassia Fistula*. *A*, indehiscent pod. *B*, longitudinal section of pod (Bai).

The Tamarind (Figs. 28 and 29) and the Carob give us yet another departure, we have a lomentum-like fruit but with fleshy pericarp and indehiscent.

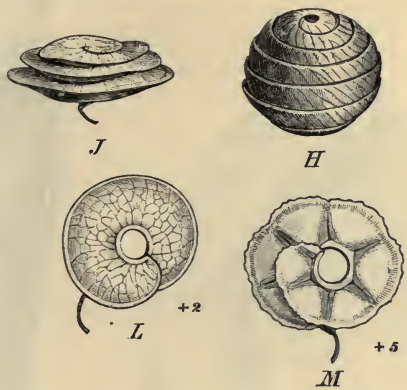


Fig. 27. Twisted fruits of Leguminosæ. *H*, *Medicago scutellata*, All. *I*, *Medicago orbicularis*, All. var *marginata*, (Willd) Benth. *L*, *Medicago obscura*, Retz. *M*, *Cyclocarpa stellaris*, Afz. (E and P).

Again, many Leguminosæ with many-seeded fruits have a more or less prominent *longitudinal* septum projecting into, but not completely invading, the cavity, from the dorsal (*Astragalus*) or the ventral (*Oxytropis*) suture.

In *Entada* (Fig. 30), the huge flattened lomentum-like pod breaks in such a manner that the separate closed compartments fall out and leave the coalesced dorsal and ventral sutures behind like a frame; and this is even more evident in some species of *Mimosa, Schrankia, Lysiloma.*

In *Hæmatoxylon* the dehiscence of the pod is by lateral slits down the centre of each valve.

All the above remarks apply to forms which are, after all, at least pod-like in form, though the transverse section varies from circular (e.g. *Cassia*) or square (some species

of *Inga*) to laterally flattened, and even winged forms (*Tetrapleura*).

Fig. 28.

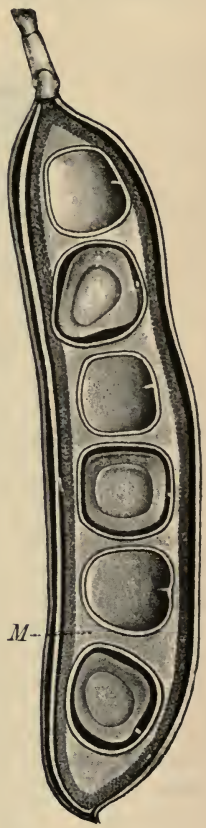


Fig. 29.

Fig. 28. *Tamarindus indica*, L. *E*, fleshy indehiscent pod. *F*, transverse section of seed. *G*, longitudinal section of seed (E and P).

Fig. 29. *Tamarindus indica*, L. Longitudinal section of pod: *M* is the fleshy mesocarp (Berg and Schmidt).

But the next departure opens up another series of forms. In very many Leguminosæ the "legume" only

Fig. 30. *Entada polystachya*, lomentum (Bai).

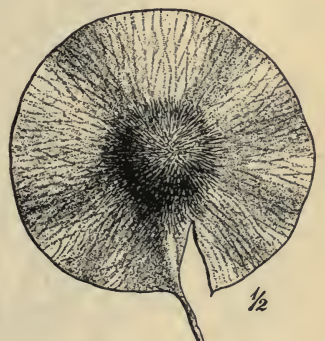


Fig. 31. *Pterocarpus erinaceus*, Poir., samara (E and P).

contains *one* seed, and hardly opens, in some species of *Trifolium*, by one suture—in *T. pratense* by a cap—while in many others it is totally indehiscent, the fruit thus becoming indistinguishable from an *Achene*. Similar achenes occur in *Dalbergia* and allies, while others have the margins prolonged into thin membranous wing-like outgrowths either on one side, or end, or all round, and so convert the fruit into a *Samara* (Fig. 31). Still more remarkable is the conversion of the mesocarp into a more or less fleshy mass covering a bony endocarp, and thus the fruit into a *Drupe*, in *Detarium, Geoffroya* and *Andira*.

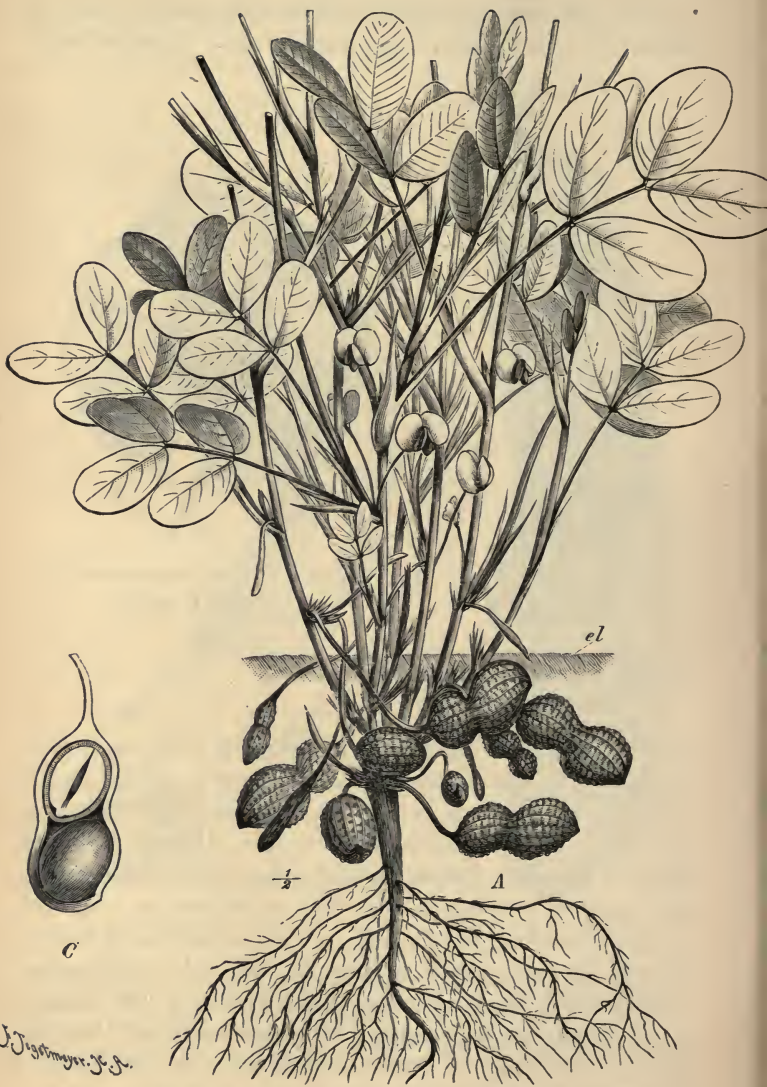


Fig. 32. *Arachis hypogæa*. *A*, whole plant showing flowers and subterranean indehiscent fruits. *C*, one fruit cut lengthwise (E and P).

In *Arachis hypogœa* (Fig. 32), *Voandzeia subterranea* and *Trifolium subterraneum*, &c. the fruiting pedicels are driven into the ground, and the maturation of the fruit completed below the surface of the soil.

In *Amphicarpœa* there are two forms of fruit on the same plant, the lower flowers producing subterranean indehiscent and 1–2 seeded achenes: the upper legumes with several seeds.

Fig. 33. *Exochorda grandiflora*, capsule (Bai).

Fig. 34. *Quillaia Saponaria*, Mol. Shoot bearing flowers and fruit (Bai).

In *Cynometra* we have the fruits on underground branches, looking as if from roots.

Another instructive series of fruits is afforded by the natural order Rosaceæ.

The simplest form here is the *Follicle* which may be single (*Neillia*, *Stephanandra*) or grouped (*Spiræa*) or joined below and so forming an imperfect *Capsule* (*Sibiræa*, *Lindleya*) or completely fused into a capsule until dehiscence (*Exochorda*, Fig. 33).

In *Eriogynia* and *Quillaia* (Fig. 34) the carpels open by both valves, and are practically *Legumes*, at first more or less joined by their ventral sutures below into an imperfect *Capsule*.

Next we find forms with only one seed in each carpel, which is indehiscent—i.e. an *Achene* (e.g. *Holodiscus*).

Next we have a series of forms in which the single carpel obtains a fleshy mesocarp and more or less bony endocarp, as in the *Drupes* of the Almond (Fig. 35)—where the mesocarp is as yet only leathery, and retains

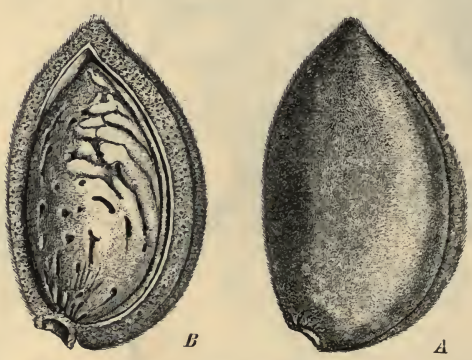


Fig. 35. Almond, *Prunus Amygdalus*, Stokes. *A*, drupe. *B*, drupe opened to show the stone (E and P).

the power of dehiscing partially—Plums, Cherries, &c. (Fig. 22). In *Prinsepia* the endocarp is leathery, and in some Chrysobalanoideæ the mesocarp is mealy, while

in others (*Parastemon*) the mesocarp is so thin that the drupe is practically an *Achene*.

In another series we find the bulging floral receptacle taking part in the (false) fruit—e.g. Potentillideæ. In *Potentilla*, &c. the torus is merely spongy, but in the Strawberries it becomes fleshy and edible, and the whole is an æterio of *Achenes*. In *Potaninia* there is only one *Achene* on the hardly swollen torus. Next comes a group with similarly bulging torus but bearing little *Drupes* (Drupels), and the various species of *Rubus* (Blackberry, Raspberry, &c.) give us examples of such an æterio of Drupels (Fig. 24).

A further variation in Rosaceæ is brought about by the depression of the carpels into the hollowed floral axis (calyx-tube). In *Geum* the *Achenes* are situated on an early flat torus, but in many of its allies it is sunk more and more deeply and the calyx creeps up around the group of achenes. In the Agrimony (Fig. 36) and *Alchemilla* the

A *B*

Fig. 36. *Agrimonia Eupatoria*. *A*, fruit. *B*, fruit cut down the centre (Bai).

few achenes are thus closely enveloped by a hard calyx-tube, but in the Roses the numerous achenes are at the base of a fleshy calyx-tube, and the whole is termed a Hip.

In the Pomaceæ (Apples, Pears, &c.) we have yet another series in which the enlarged calyx-tube is pro-

minent and gradually undergoes profound changes, and eventually fuses with the enclosed fruits proper.

In *Cotoneaster* the stony achenes are only united at their extreme ventral bases, but their other sides join with the swollen but hardly fleshy calyx-tube; in *Cratægus* (Hawthorn, Fig. 37) the fleshy calyx-tube fuses to the stone-like achenes, and so the whole forms the drupe-like Haw.

Fig. 37. Hawthorn, *Cratægus Oxyacantha*. 1, flowering shoot; 2, fruit; 3, section across latter (Wo).

In the Quince, Apple, Pear, &c. the much enlarged and fleshy calyx-tube invests and fuses with the several-seeded, horny true fruits, each of which is structurally a follicle. The whole results in a berry-like inferior false fruit, known as a *Pome*.

CHAPTER IV.

FRUITS OF THE RANUNCULACEÆ, NYMPHÆACEÆ, MAGNOLIACEÆ, ANONACEÆ, AND BERBERIDACEÆ.

Fruits of Ranunculaceæ—Follicles—Capsule—Berry—Achenes—Fruits of Nymphæaceæ. Fruits of Magnoliaceæ. Fruits of Anonaceæ. Fruits of Berberidaceæ.

In the Ranunculaceæ and their allies the student will find an instructive series of fruits.

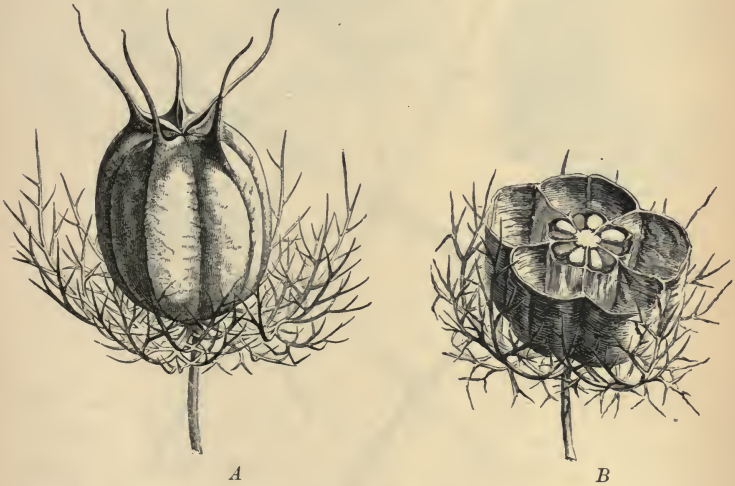


Fig. 38. *Nigella damascena*. *A*, capsule. *B*, capsule with the top cut off (Bai).

In the Hellebores, *Caltha* (Fig. 3), Peonies, Columbines, Larkspurs, Monkshoods (Fig. 7), &c. we have an æterio of *Follicles*: they dehisce by the dorsal suture in *Glaucidium*, also in *Xanthorrhiza* whose follicles are 1-seeded. In *Nigella* the circle of follicular carpels fuse to a septicidal *Capsule* with inflated dorsal walls in *N. damascena* (Fig. 38). In *Hydrastis* and *Actæa* we have a similar fusion,

Fig. 39. Traveller's Joy, *Clematis Vitalba* (Sch).

but the pericarp is fleshy, and so a *Berry*-like fruit: in *Actæa spicata* there is only one carpel, which ripens to a *Berry*.

In *Callianthemum* there is one *Achene*, but in most Anemones, Buttercups (Fig. 15), *Clematis* (Fig. 39), &c. the fruit is an æterio of achenes.

In Nymphæaceæ we find the following interesting series of fruits:—

In *Cabomba*, &c. there is an æterio of free indehiscent *Follicles* or *Achenes*. In *Nelumbo* (Fig. 40) the achenes are sunk in deep depressions of the floral axis. In *Nymphæa* (Fig. 41), *Nuphar*, &c. (the Water Lilies) the

Fig. 40. *Nelumbo lutea*, Pers., flower and fruit (E and P).

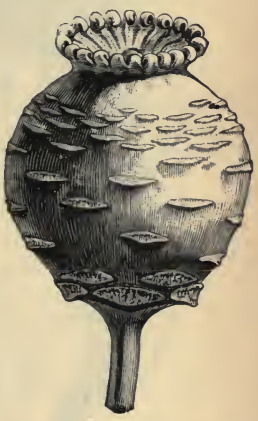


Fig. 41. *Nymphæa alba*, capsule (Bai).

numerous carpels unite into a capsule-like fruit with numerous chambers and seeds, but the walls become spongy or nearly fleshy, and do not dehisce as a rule. The fruit is thus something combining the characters of a berry and a capsule. In *Nuphar* it is superior: in

Nymphæa it is more or less inferior, and in *Victoria* quite inferior.

In Magnoliaceæ the fruits are *Follicles* almost united into a capsule. In *Magnolia* (Fig. 42) we have every stage from true follicles opening by the dorsal suture, to such which open by a ring-like dehiscence; and in *Talauma* they may burst irregularly or not at all. In *Drimys* and *Schizandra* the pericarps become fleshy, and we have *Berries* with two or three seeds. In *Liriodendron* (Fig.

Fig. 42.

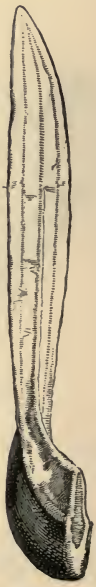


Fig. 43.

Fig. 42. *Magnolia Yulan*, æterio of follicles (Bai).

Fig. 43. *Liriodendron tulipifera*, Tulip-tree, achene (Bai).

43) the seeds are reduced to one, and the fruits are achenes.

The fruits of the Anonaceæ also offer an interesting series of examples. The simplest case is in *Anaxagorea*, which has an æterio of *Follicles*; in others (e.g. *Xylopia*) there is an æterio of indehiscent *Lomentum*-like fruits,

Fig. 44.

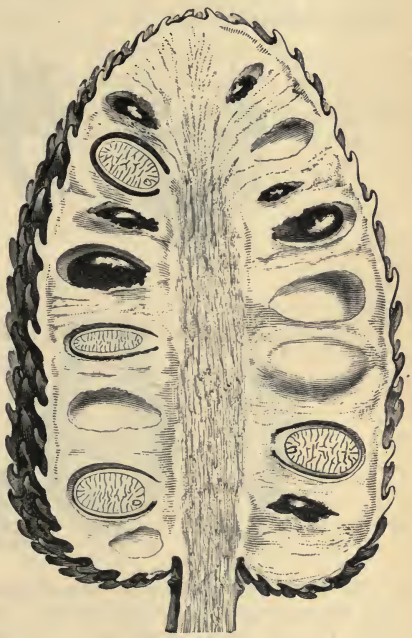


Fig. 45.

Fig. 44. *Unona discolor*, fruit (Bai).

Fig. 45. Sour-Sop, *Anona muricata*, L, longitudinal section of fruit (E and P).

with fleshy pericarps, and often (e.g. *Uvaria* and *Unona*, Fig. 44) strangulated between the seeds; while in many the fleshy indehiscent pericarps are stalked, and contain

but one seed (some species of *Uvaria*, *Guatteria*, &c.). They thus form an æterio of Berries.

In others the carpels are free (apocarpous) in the flower, but fuse as they ripen to a fleshy aggregate—a sort of compound berry (*Anona*, *Duguetia*, *Ararocarpus*, &c.) often called "Custard Apple," "Bullock's Heart," "Sour-Sop" (Fig. 45), &c., in the flesh of which the seeds are embedded.

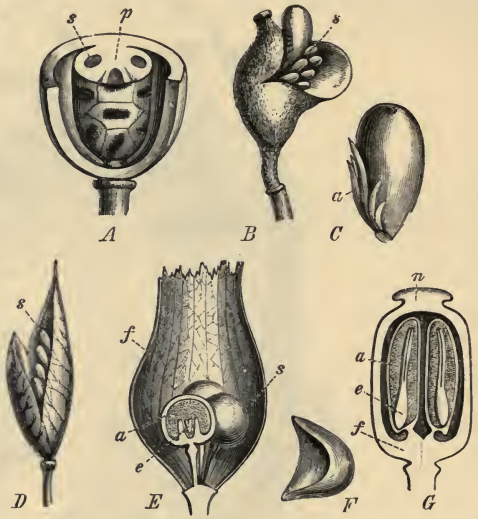


Fig. 46. Berberidaceous fruits and seeds. *A*, *Podophyllum peltatum*, fruit cut transversely and longitudinally. *B*, *Jeffersonia diphylla*, Pers., fruit. *C*, *Ibid.*, seed; *a*, aril (4/1). *D*, *Epimedium alpinum*, L, fruit. *E*, *Leontice Leontopetalum*, L, longitudinal section of fruit; *a*, pericarp. *F*, *Achlys triphylla*, DC, fruit (3/1). *G*, *Berberis vulgaris*, L, longitudinal section of fruit and seeds; *a*, endosperm.—*e*, embryo; *f*, pericarp; *n*, stigma; *p*, placenta; *s*, seed (E and P).

The Berberidaceæ give another interesting set of examples, especially showing the variations possible with one free carpel.

In *Epimedium* (Fig. 46, *D*) the *Follicle*-like monocarpic fruit splits down the two sides so that one of the valves carries the placenta and seeds along the middle of its inner face; while in *Jeffersonia* (Fig. 46, *B*) we have a similar fruit splitting transversely to the long axis. In *Leontice* (Fig. 46, *E*) we have a similar fruit splitting irregularly at the apex, or by throwing off a lid-like apical portion of the carpel. In *Achlys* (Fig. 46, *F*) the seed is reduced to one, and the fruit is an *Achene*. In others (*Berberis*, Fig. 46 *G*, *Podophyllum*, Fig. 46 *A*) the single carpel has several seeds and ripens to a fleshy Berry.

CHAPTER V.

FRUITS OF RUBIACEÆ.

Fruits of Rubiaceæ—Capsules—Cocci—Berry—Drupe-like Fruits—Infructescences.

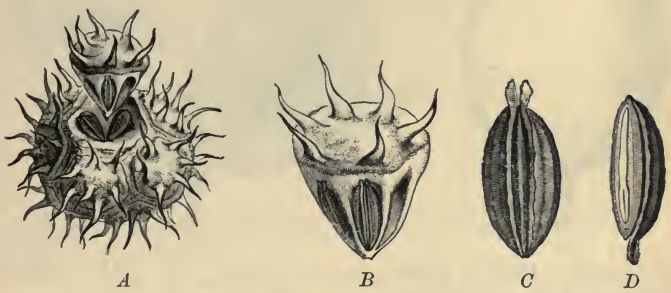
THE family Rubiaceæ affords excellent examples of varieties of inferior capsules and berries, and of collective fruits composed of these, as well as of other types of fruits; and their characters are largely employed in classifying this largely tropical order.

Fig. 47. *Isidorea amœna*, Rich., capsule (E and P).

Fig. 48. *Mitracarpus hirtus*, DC, pyxis dehiscing (E and P).

Beginning with many-seeded capsules of all sizes and shapes, which are bi-, quadri- or pluri-locular, the play is

chiefly on the mode of dehiscence—*septicidal* (*Condaminea*, &c.) or *loculicidal* (*Isidorea*, Fig. 47, &c.), or by a lid (*Pyxis*) as in *Argostemma*, *Mitracarpus* (Fig. 48), and the infructescences of *Opercularia* (Fig. 49) and *Pomax*. Then we have a series where the capsule remains indehiscent (*Dentella*, &c.).



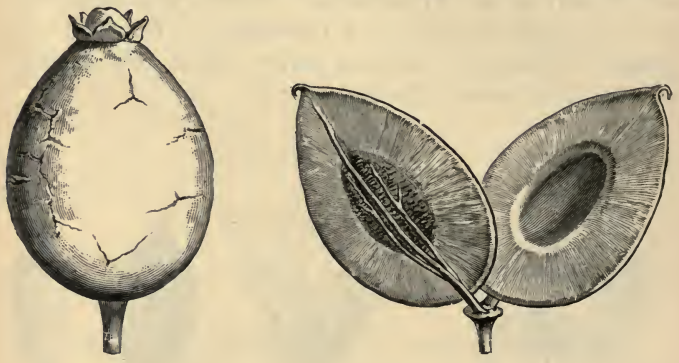
A *B* *C* *D*

Fig. 49. *Opercularia aspera*. *A*, pyxis-like infructescence dehiscing. *B*, operculum of infructescence bearing several fruits. *C*, single fruit. *D*, longitudinal section of single fruit (Bai).

Now the play sets in in two noteworthy directions: first, in the reduction of the seeds to two or even one, and, second, in the passage of the mesocarp through a leathery consistency to a succulent one.

In cases where the seeds are reduced to one in each carpel or chamber, we often have the valves separating and each enclosing its seed, to which it forms an investment. These mericarps look like *Achenes*, but it is customary to call such forms *Cocci* (Fig. 50). In some—e.g. *Xanthophytum*, *Diodia*, &c.—we have the closed mericarps simply falling away, and very like achenes; in others—e.g. *Cremocarpus*—the two mericarps remain attached for a time to the carpophore, as in the fruit (*Cremocarp*) of an umbellifer. In *Adina*, &c. the cocci split after separating, whereas in *Galium* (Figs. 51, 52),

&c. they do not separate at all, but the whole fruit, evidently lobed into cocci, comes away from the stalk.



A *B*

Fig. 50. *Pæderia fœtida.* *A*, fruit not yet split (3/1). *B*, fruit splitting into two cocci (Bai).

As an instance of how many of these variations may occur in a small circle of alliance, we find in the genus

Fig. 51.

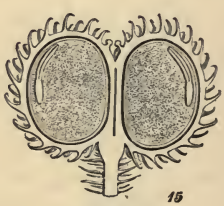


Fig. 52.

Fig. 51. *Galium saccharatum*, L, longitudinal section of fruit; *v*, undeveloped ovary-chamber (E and P).

Fig. 52. *Galium uncinulatum*, DC, longitudinal section of fruit (E and P).

Oldenlandia true inferior capsules, both loculi- and septisidal, indehiscent capsules, and cocci.

Again in genera like *Vangueria*, *Plectronia*, &c. we find every stage of succulence of the carpels coming in together with reduction of the seeds to two or even one.

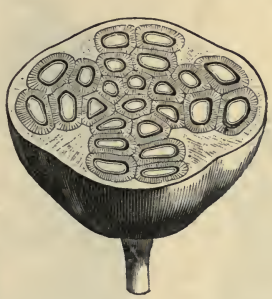


Fig. 53. *Guettarda Pervilleana*, transverse section of fruit (Bai).

Two sets of cases now occur. In one the endocarp remains thin, and we have *baccate* forms, few or many seeded, and in *Mussænda*, &c. we see the transition from capsular to baccate forms in one and the same genus.

In another set of cases the endocarp begins to harden (e.g. *Isertia*) and finally becomes a hard shell, and a series of many-seeded or many-stoned *drupaceous* forms appear —e.g. *Alberta*, *Pyrostria*, *Guettarda* (Fig. 53), &c.—a difference being noted whether there are several bony endocarps each enclosing one seed, or a single but chambered bony mass with one seed in each of its chambers. When, as in *Salzmannia*, the seed is reduced to one in the bony endocarp we have a fruit indistinguishable from a *Drupe*, except in its origin from an inferior *syncarpous* ovary, and by abortion of seeds.

Finally we have several genera of Rubiaceæ forming collective fleshy fruits (*Infructescences*) as in *Sarcocephalus*, where they are baccate, and *Morinda* (Fig. 54), where they are drupaceous. In *Ourouparia*, *Adina*,

Anthocephalus, Nauclea, &c. the same collection of the fruits into dense heads is seen, but since the fruits them-

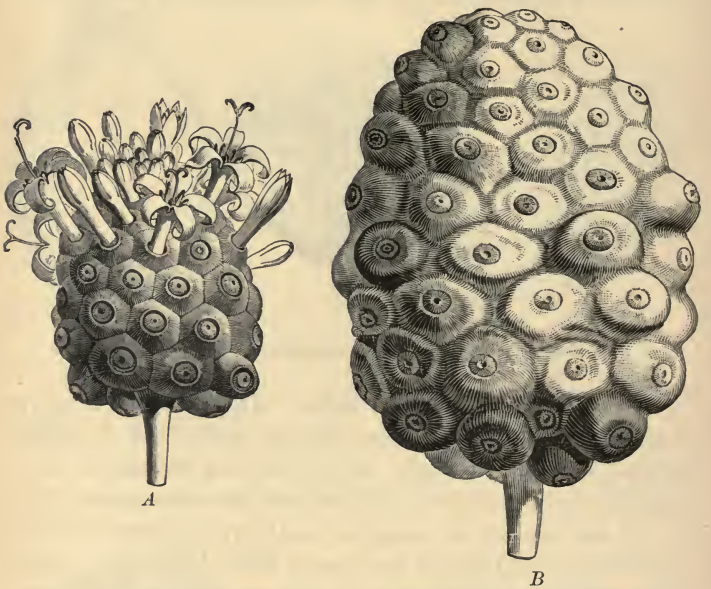


Fig. 54. *Morinda citrifolia.* *A*, inflorescence. *B*, infructescence (Bai).

selves are capsular there is of course no fusion, and we are apt to overlook the fact that these give us examples of an infructescence.

CHAPTER VI.

FRUITS OF CRUCIFERÆ AND CAPPARIDACEÆ.

Fruits of Cruciferæ — Silique — Silicle — Occasional Absence of Septum—Indehiscent Fruits—Lomentum-like Fruit—Achene —Winged Fruits—Samara—Cremocarp—Dimorphic Fruits—Subterranean Fruits. Fruits of Capparidaceæ—Silique—Indehiscent Dry Fruits—Winged Achene—Fleshy Fruits—Baccate Fruits—Lomentum-like Fruits—Transitional Fruits—Drupe.

THE Cruciferæ and their allies the Capparidaceæ afford another series of instructive fruits, much used in classification.

Most crucifers have a *Silique* (Fig. 8) or—when not longer than broad—*Silicule* (Fig. 55); but several forms occur in which the membranous partition is lacking—e.g. the Silique of *Tropidocarpum*—a state of affairs which is normal in many Capparidaceæ. In another set of examples the Silique remains indehiscent (*Andreoskia,*

Fig. 55. *Capsella Bursa-pastoris*, silicule (Bai).

Raphanus), or is jointed transversely like a *Lomentum* (*Raphanus*, Fig. 56) and breaks across at the segments.

In another series of cases we find the short silicules with few seeds indehiscent, sometimes devoid of the partition. When, as in *Myagrum*, *Crambe* (Fig. 57), &c., this occurs and the seed is reduced to one, the fruit is practically an *Achene*.

Fig. 57 *A*.

Fig. 57 *B*.

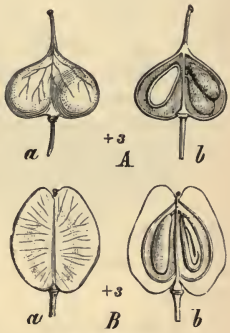


Fig. 58.

Fig. 56.

Fig. 56. *Raphanus Raphanistrum*, fruit (Bai).

Fig. 57. *Crambe maritima*, Sea-kale. *A*, fruit. *B*, longitudinal section of fruit (Bai).

Fig. 58. *A*, *Lepidium Draba*, L, unwinged fruit; *B*, *Lepidium sativum*, L, winged fruit: *a*, complete fruit; *b*, longitudinal section of fruit (E and P).

Winged siliques, silicules (*Lepidium*, Fig. 58, *Megacarpæa*), and achenes (*Peltaria*) are also common, and in the last case are to all appearances *Samaras*, as in the 1-seeded form of *Aethionema*.

In some genera (e.g. *Cremolobus*, Fig. 60) the two halves of the silicule come away from the axis enclosing each its single seed, like mericarps from the carpophore in a *Cremocarp*, only in comparing with the fruit of umbellifers we must remember it is here *superior*.

Some crucifers bear two kinds of fruit on the same plant—e.g. achene and silicule in *Aethionema*, lomentum and silique in *Chorispora*, and even siliques and silicules in *Cardamine*, the latter ripening underground. Subterranean silicules also occur in *Geococcus* and *Morisia*.

Fig. 59 *A*.

Fig. 59 *B*.

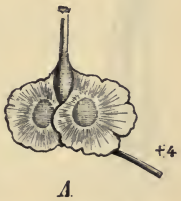


Fig. 60.

Fig. 59. *Aethionema coridifolium*. *A*, winged fruit. *B*, longitudinal section of winged fruit (Bai).

Fig. 60. *Cremolobus suffruticosus*, DC, schizocarp with winged mericarps (E and P).

In the Capparidaceæ the simplest typical fruit is like a silique, but without the longitudinal partition, so that when the valves of the *capsule* separate they leave the seeds on the margins of the replum, but the latter has no membrane across—e.g. *Cleome* (Fig. 61)—but here again each valve may come away like a mericarp, bringing the single seed (the rest being aborted) with it—e.g. *Wislizenia*. In *Dipterygium* (Fig. 62) the fruit is indehiscent, has only one seed, and is winged, like a samaroid achene.

Next we get a series where the pericarp becomes fleshy and the fruit is therefore Baccate. In *Capparis*

it has several chambers, but in others the placentæ are parietal and the fruit a one-chambered *Berry*. In *Mærua* (Fig. 63) the berry is elongated and constricted like a Lomentum. The transition from capsule to berry is shown where the fruit opens like a capsule, but is fleshy—a dehiscent berry.

Fig. 61.

Fig. 62.

Fig. 63.

Fig. 61. *Cleome spinosa*, fruit dehiscing (Bai).
Fig. 62. *Dipterygium glaucum*, Desne., winged indehiscent fruit (E and P).
Fig. 63. *Mærua angolensis*, DC, berry (E and P).

Forchhammeria has a berry-like fruit with a thin papyraceous endocarp, and shows the transition to the *Drupes* of *Roydsia* and *Stixis*, only we must not forget that the Drupe is here formed from more than one carpel.

CHAPTER VII.

FRUITS OF URTICIFLORÆ.

Achene—Fleshy Perianth or Bracts—Samara—Samaroid Drupe—Drupe—Infructescences—"Receptacle" of Infructescence.

ONE of the most interesting and instructive series of fruits known is that of the great Natural Order including the Fig—the Urticifloræ, in the wide sense.

In the simplest cases we have dry *Achenes*, often

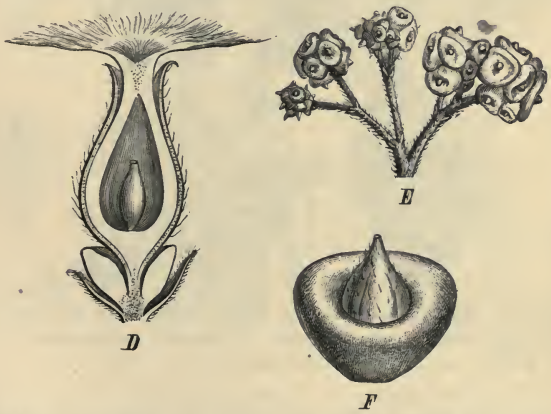


Fig. 64. *Villebrunea integrifolia*, Gaudich. *D*, vertical section of female flower showing the basin-like expansion of its pedicel. *E*, part of the infructescence. *F*, fruit. (E and P.)

enclosed by the papery or membranous perianth-lobes (e.g. Nettle), which however may become fleshy (e.g. *Urera*, &c.) In other cases (e.g. *Villebrunea*, Fig. 64) the bracts are fleshy and enclose the achenes. In the Hop (Fig. 65)

Fig. 65. *Humulus Lupulus*. 1, branch with male inflorescence; 2, branch with female inflorescences; 3, female inflorescence; 4, two female flowers with bract; 5, infructescence; 6, fruit (Wo).

the achenes are in the axils of the large bracts of the "cones." In *Memorialis*, and in the Elms (Fig. 66), &c. the achene has wings and is a *Samara*, the pericarp of

which is more or less fleshy, and the endocarp bony in *Pteroceltis* (Samaroid Drupe). In *Celtis* it is a Drupe.

The tendency throughout the group is for the female flowers, and therefore the fruits, to be aggregated in dense clusters or spikes, heads, &c. This is well seen in *Bœhmeria*, and is forshadowed in the Elms (Fig. 66), &c. In some—e.g. *Procris*—the globoid end of the inflorescence swells to a fleshy mass on which the achenes are borne: this simulates a strawberry, but here each achene comes from a separate flower, and the whole is an infructescence, not a true æterio.

Fig. 66. Elm, *Ulmus campestris*. 1, flowering shoot; 2, twig of the preceding year, with tuft of fruits and a dwarf shoot bearing foliage; 3, a flower; 4, ovary; 5, fruit; 6—8, seeds; 9, buds (Wi).

As we pass into the Mulberry and Fig group, this

tendency to condensed infructescences becomes more pronounced. In *Bleekrodea, Paratrophis,* &c. the fruits are drupaceous, and in the former enveloped in the perianth: in *Morus* (Fig. 2), *Maclura, Broussonetia,* &c. this envelope becomes fleshy also, and since the dense heads of flowers almost fuse as the drupes ripen, we have an infructescence simulating the æterio of *Rubus.* In *Coussapoa,* &c. the *drupels,* enclosed in their perianths, are aggregated similarly on club-shaped or globoid receptacles. In *Plecospermum* the fusion is still closer and the end of the

Fig. 67. *Artocarpus incisa,* flowering and fruiting branch (Bai).

peduncle becomes fleshy also, thus forming a globoid syncarp.

Now comes in a curious new departure, and the end of the floral stalk (Receptacle[1]) enters more and more into the structure of the syncarp. In *Dorstenia* the end of the peduncle expands to a flat or slightly concave, variously shaped, fleshy receptacle, in which the small drupes are imbedded.

In *Artocarpus* (Fig. 67) and its allies the same imbedding occurs, but the achenes and their free or fused, membranous or pulpy perianths, are in a fleshy club-shaped or globular receptacle, in some cases much larger than a man's head and weighing many pounds.

Fig. 68. Fig, *Ficus Carica*. 1, flowering shoot; 2, female, and 3, male flower enlarged; 4, the fig in section, reduced (Wo).

In the Figs the fleshy receptacle is deeply concave, and the achenes are situated on its inner walls.

[1] N.B. This term is used in an unusual sense to denote the terminal part of the inflorescence-axis.

PART II.

SPECIAL.

In order to facilitate the running down of species in the following classification, the signs in the accompanying list are used in sequence and indented as below:—

CLASSIFICATION OF TREES AND SHRUBS ACCORDING TO THEIR FRUITS AND SEEDS.

I. SEED NOT IN A FRUIT, BUT EXPOSED FROM THE FIRST; SINGLE, OVOID, BROWN AND NUT-LIKE, INVESTED BY A CUP-LIKE SOFT SCARLET ARILLUS.

Taxus baccata, L. Yew (Fig. 69). The apex of the seed is slightly pointed but devoid of scar; base with annular surface of attachment. Seed about 10 mm. long, very slightly compressed. Scales at base of arillus.

The proof of the morphological nature of the so-called Yew "berry" depends on the study of development; but the absence of any stigmatic scar, the simple structure of the seed-coat, and the endosperm and embryo can be determined in the field.

Any superficial resemblance to an Acorn in its cup is easily discounted by comparison and especially on careful dissection.

II. SEEDS ENCLOSED BETWEEN THE SCALES OR WITHIN THE WALLS OF A FRUIT.

A. SEEDS ON THE INNER FACES OF THE SCALES OF A DRY WOODY CONE, AND SHED FROM BETWEEN THE SCALES ON RIPENING. [For (B) see p. 78.]

(1) Cones sessile, and composed of single or double scales closely imbricated on an axis. [For (2) see p. 78.]

Fig. 69. Yew, *Taxus baccata*, L. 1, branch with male flowers; 2, shoot with two ripe "berries"; 3, young male flower; 4, the same exposing and emptying the anthers; 5, anthers; 6, female flower; 7, the same in section; 8, details of the same: *, micropyle; *ls*, the single integument; *x*, outer part of nucellus which hardens to form the shell; *nc*, nucellus with embryo-sac and endosperm (*edp*); *cp*, archegonia ("corpuscula"); *a*, arillus; *b*, scales. 9, nearly ripe "berry": *a*, arillus; *is*, seed. 10, ripe "berry" in section: *a*, arillus; *e*, embryo. 11, needle and its transverse section; 12, the same of Silver Fir, and 13, of Spruce (Wi).

Fig. 70. Austrian Pine, *Pinus Laricio*, Poir. 1, shoot with male flowers; 2, apex of shoot bearing female flower, the dwarf shoots still young; 3, cone; 4, the same shedding seeds; 5—9, ovules and seeds; 10, pair of needles; 11, the same in section (Wi).

(a) **Cone-scales spirally inserted; seeds with a thin membranous wing, in pairs on the scales; all trees with very narrow linear, acicular or scaly leaves (Conifers).** [For (b) see p. 78.]

[For (ii) see p. 69.]

(i) Ripe cone tapering from a broad base, erect or spreading; scales thickened at the free end into a rhomboidal apophysis, with keel and minute umbo; seeds with easily separable wings clasping them below; acicular leaves in tufts of 2 or 3.

[For (β) see p. 68.]

(*a*) *Umbo not prolonged into a prickle or hook: leaves in tufts of* 2.

* Cones 3—6 cm. long, brown; seeds 3—6 mm.; seed-wing brown, 15—25 mm., somewhat pointed.

† Wing 15—20 mm. × 5—6 mm., broadest just below middle.

Pinus Laricio, Poir., var. *austriaca*. Black Pine, Austrian Pine (Fig. 70).

†† Wing 15—20 mm. × 5—6 mm., greatest breadth in the middle.

Pinus sylvestris, L. (Fig. 71.)

Pinus montana is very similar to *P. sylvestris*, but the seed is rounder, smaller and more shining, and the cone also somewhat smaller with a blackish ring on the slightly prickly umbo.

** Cones 10—18 cm.; seed-wings 25—40 mm. long; seeds 9—22 mm.

† Cones fawn-yellow or reddish, shining, 12—18 cm. long, oblique; seeds small, nearly black, 9—10 mm. long, and their large obliquely acute wings 40 mm. long, with violet streaks.

Pinus Pinaster, Soland. Cluster Pine (Fig. 72).

†† Cones 10—15 cm., reddish-brown, shining, the minute umbo in a depression; seeds

large, 20—22 mm.; seed-wings small, only projecting about 5—6 mm. beyond the apex of seed, almost truncate.

Fig. 71. Scots Pine, *Pinus sylvestris*, L. 1, apex of shoot bearing a female flower; 2, branch with male flowers; 3, cone; 4, the same shedding seeds; 5, female flower; 6, 7, 8, ovular scale with carpellary scale seen from various aspects; 9—12, seeds; 13, male flower; 14, 15, empty stamens; 16, 17, pollen-grain; 18, seedling; 19, pair of needles; 20, the same in transverse section (Wi).

Pinus Pinea, L. Stone Pine (Fig. 73).

(β) *Umbo prolonged slightly to a small prickle*

Fig. 72. *Pinus Pinaster*, Cluster Pine. 1, ripe cone; 2, seed deprived of its wing, seen from above; 3, wing of seed seen from below; 4, winged seed, seen from above. (All natural size, after von Tubeuf.)

or hook; leaves in tufts of 3. *Cones* 8—12 *cm.; seeds* 6—7 *mm.; seed-wing* 25—28 *mm. in length.*

Pinus Taeda, L. Torch Pine.

(ii) Ripe cone cylindroid or rounded and blunt;

Fig. 73. *Pinus Pinea,* L. 1, ripe closed cone; 2, cone-scale viewed from above; 3, mature seed; 4, cone-scale viewed from below; 5, detached wing of seed. (All reduced, after von Tubeuf.)

scales thin and not thickened conspicuously into an apophysis.

[For (β) see p. 72.]

(*a*) *Apophysis slight and oblique, and umbo a mere point to the scale; leaves* 5 *in a tuft.*

Fig. 74. *Pinus Strobus*, L. 1, open ripe cone; 2, cone-scale viewed from below; 3, cone-scale viewed from above; 4, winged seed seen from above; 5, seed forcibly deprived of its wing and seen from below; 6, shoot with growing spring-shoots and two cones of the preceding year. (All reduced, after von Tubeuf.)

Fig. 75. *Pinus Cembra*, L. 1, shoot with young and one-year-old cones, in summer; 2, ripe cone in its second autumn; 3, cone-scale viewed from above; 4, cone-scale viewed from below; 5, detached wing of seed; 6, seed; 7, transverse section of leaf; 8, seedling in its second spring, showing cotyledons and primary leaves; 9, tip of cotyledon viewed from above; 10, tip of primary leaf viewed from above. (All reduced, after von Tubeuf.)

* Cones cylindroid, pendent, slightly curved, 15—25 cm. long, much longer than broad; seed-wing 3—4 times as long as marbled seed.

† Cone 15—18 cm. long; seed 5—7 mm. long; seed-wing 25 mm. long, oblong-oblique, with nearly parallel edges.

Pinus Strobus, L. Weymouth Pine (Fig. 74).

[*Pinus monticola* has a somewhat larger cone, stiffer and less serrulate leaves, and smaller seeds and wings than *P. Strobus*.]

†† Cone 18—24 cm. long; seed 7—8 mm. long; seed-wing 30—40 mm. long, wider just below middle.

Pinus excelsa, Wall. Himalayan Pine.

** Cone ovoid-obtuse, erect, 8—10 cm. long, and seeds 8—12 mm. long with a very short broad wing projecting only 2—4 mm.

Pinus Cembra, L. Arolla Pine (Fig. 75).

(β) *Apophysis and umbo wanting; scales thin and rounded; leaves not in twos, threes or fives.*

* Cones cylindroid, erect; the rounded scales falling when mature; seed triangular, with oleo-resinous coats, wing inseparable.

Abies pectinata, DC. Silver Fir (Fig. 76). Cone 18—32 cm. long × 5—6 cm. wide. The barren scale projects beyond the ovuliferous scale and ends in a sharply reflexed mucro. Seeds 10—12 mm. long, triangular, with a weak, easily crushed shell abounding in balsam. Wing somewhat obliquely rectangular 20—22 × 5—7 mm., and is with difficulty removable. Leaves linear, isolated, pectinate in arrangement.

Fig. 76. Silver Fir, *Abies pectinata*. 1, ripe cone; 2, placental scale and seeds from within; 3, the same with seeds fallen; 4, scale from without, showing the smaller carpellary scale; 5, seeds with wing, the † points to the inturned part holding the seed; 6, seed with wing removed, the * points to a resin gland; 7, piece of shoot with leaf-scars; 8, axis of ripe cone from which the seeds and scales have fallen (Wi).

Other species of *Abies* are similar.

** Cones not shedding the scales at maturity.

Fig. 77. *Pseudotsuga Douglasii*, showing the pendent cone, and exserted three-pronged carpellary scales (V).

† Cones pendent, ellipsoid, with exserted barren scales, which are not reflexed and end in three linear-acute projections; seed small, triangular, with a large oblong wing.

Pseudotsuga Douglasii, Carr. Douglas Fir (Fig. 77). Leaves linear-falcate, in 3—4 ranks, spiral. Cones 8—12 cm. long, slightly tapering to each end; seeds with a hard shell, devoid of resin, sharply triangular, 5—7 mm. long, with an obliquely inserted, inseparable, nearly oval wing, 14—15 mm. long.

†† Cones not provided with trifid exserted barren scales.

⊙ *Cones pendulous, cylindroid; barren scales not exserted; seeds small, tear-shaped, with relatively large separable wings; leaves spirally crowded and 4-angled in section.*

Picea excelsa, Lk. Spruce (Fig. 78). Cones 12—18 cm. long × 3—6 cm. broad, the scales rounded, thin, and toothed at edges. Seed 4—5 mm. long; wing suddenly expanded, oval, about 15 × 6—7 mm.

⊙⊙ *Cones not pendulous nor cylindroid, but more or less ovoid; seed-wing not separable nor rounded oblong. Leaves in tufts of more than* 20.

▱ *Cones about* 9—12 *cm. long, erect, oblong-ovoid, blunt, with numerous densely imbricated scales; seeds with very broad and oblique wings. Leaves in tufts of persistent needles.*

Cedrus Libani, Barr. Cedar of Lebanon. The seeds are elongated and soft-shelled, rich in resin, 10—12 × 4—5 mm., with an inseparable, large, nearly triangular wing about 40 mm. long × 30 mm. broad. The cones may be slightly depressed above.

Fig. 78. Spruce, *Picea excelsa*, Lk. 1, shoot with male flowers, and at 12, a *Chermes* gall; 2, female cone terminating a shoot; 3, ripe cone; 4, 5 and 6, cone-scales; 7, seeds; 8, stamens; 9, leaf and its transverse section; 10 and 11, seedling (Wi).

The cones of *C. Deodara* (Fig. 79), are about the same size or even a little larger, but the seeds somewhat smaller;

Fig. 79. Deodar, *Cedrus Deodara*, Loud. Shoot with ♂ and ♀ cones. *A*, seed-bearing scale; *B* and *C*, stamens (E and P).

while the cones of *C. atlantica* are considerably smaller, about 5—6 × 4 cm.

▱▱ *Cones 3—5 cm. long, with fewer and much looser scales, just showing the tips of the barren scales; seeds with obliquely sub-acute narrow wings; leaves in tufts of 25—60 and deciduous.*

Larix europæa, L. Larch (Fig. 80).

(b) **Cones small, the scales not spiral, but opposite and decussate; seeds not truly winged, but with a narrow membranous border; leaves scaly, opposite.**

(i) Cones globoid, of 8—10 scales, which are peltate at the ends, each bearing several seeds, the latter small, 6 × 4 mm., irregular and hardly winged.

Cupressus sempervirens, L. Roman Cypress (Fig. 81).

(ii) Cones elongated, of 8—12 imbricated narrow scales, which are not peltate; scale with 2—5 seeds, which are bordered with a narrow membrane.

Thuja gigantea, Nutt. Arbor Vitæ (Fig. 82).

2. [*Juniperus* has fleshy cones forming the so-called "berries"; see p. 135.]

B. SEEDS NOT SHED FROM BETWEEN THE SCALES OF A WOODY CONE.

[The cone-like infructescences of *Alnus* bear scales of complex structure, on which are borne seed-like fruits; neither these nor the catkins of *Betula*, *Myrica*, &c. are morphologically equivalent to true cones; see pp. 97, 95, 122. The fleshy cone of *Juniperus* is dealt with on p. 135.]

Fig. 80. Larch, *Larix europæa*, DC. 1, branch bearing a long shoot and several dwarf shoots, and (*a*) a proliferous cone; 2, shoot with male (♂) and female (♀) flowers; 3, male flower; 4 and 5, unopened, and 6, ruptured stamens; 7 and 8, scale of female flower seen from without and within; 9, ovuliferous scale; 10, cone; 11—14, seeds; 15, dwarf shoot in section; 16, leaf and its section (Wi).

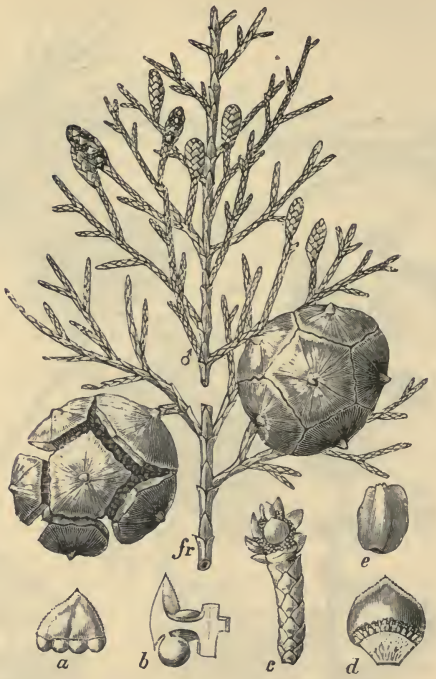


Fig. 81. Roman Cypress, *Cupressus sempervirens*, L. ♂ shoot with staminate flowers; *fr* shoot with ♀ cones; *a* stamen seen from behind; *b* the same in longitudinal section; *c* a ♀ flower; *d* one of its scales seen from within, showing the numerous erect ovules; *e* seed (E and P).

Fig. 82. *Thuja gigantea.* Ripe closed cone and winged seed (both magnified) and seed (natural size). (After von Tubeuf.)

(1) Fruits dry, leathery or woody or membranous. [For (2) see p. 118.]

(a) **Fruit dehiscent; opening by valves.** [For (b) see p. 95.]

(i) Fruit a legume; superior, of one carpel, with the seeds on one suture only, splitting into two valves. Hilum relatively large. [For (ii) see p. 82.]

(*a*) *Legume glabrous.*

* Legume 70—80 mm. long, compressed; seeds brown streaked with black, hooked.

Robinia Pseud-acacia, L. False Acacia.

** Legume 30—40 mm. long at most.

† Legume brown, 12—15 mm. long, inflated and curved; seeds shining, black.

Genista anglica, L. Petty Whin.

†† Legume 20—35 mm. long, black, compressed; seeds shining, olive.

Sarothamnus scoparius, Koch. Broom.

(*β*) *Legume hairy.*

* Legume grey silky, constricted, 50—60 mm. long; seeds shining, bluish or brownish-black.

Cytisus Laburnum, L. Laburnum (Fig. 83).

** Legume not more than 15—20 mm. long, few-seeded.

† Legume velvety pubescent, black with brown hairs, about 15 mm. long; seeds olive, hilum oval.

Ulex europæus, L. Furze, Gorse (Fig. 84).

†† Legume 8—10 mm. long; hilum orbicular.

Ulex nanus, L. Dwarf Furze.

(ii) Fruit not a legume, of 2—5 carpels and splitting by as many valves; hilum minute.

[For (β) see p. 93.]

(*a*) *Seeds minute, numerous, comose.*

[For (**) see p. 93.]

* Capsule 2-valved, small in the axils of simple scales of a cylindrical catkin, which is 5—10 cm. long; seeds numerous, minute, and silky comose.

[For (††) see p. 87.]

† Fruiting catkins pendent; scales incised.

⊙ *Catkins dense; scales dentate only, glabrous or nearly so; capsule ovoid, glabrous.*

Fig. 83. *Cytisus Laburnum*, Laburnum. *a*, inflorescence (1/2); *b*, flower; *c*, calyx opened out; *d*, standard; *e*, wing; *f*, keel; *g*, pistil; *h*, stigma; *i*, stamen; *k*, ripe fruits; *l*, seed; *m*, seed in longitudinal section; *n*, seed in transverse section. (After Schneider, except *a* and *k* after Hempel and Wilhelm.)

Populus alba, L. White Poplar (Fig. 85).

⊙⊙ *Scales of the catkin deeply incised, laciniate.*

▱ *Catkins dense; scales densely ciliate; capsule ovoid, glabrous.*

Fig. 84. *Ulex. a—h U. europæus*: *a*, flower (α = bracteole, β = calyx); *b*, fruit (γ = corolla, δ = pod); *c—c²*, standard, wing, and keel; *d*, pistil in longitudinal section, and magnified stigma; *e*, androecium opened out; *f*, seed; *g*, longitudinal and transverse sections of seed; *h*, branch. *i—k*, *U. nanus*: *i—i²* = *c—c²*; *i³*, bracteole; *k*, branch; *l*, *U. parviflorus*, branch; *m*, *U. welwitschianus*, branch. (After Schneider.)

Fig. 85. *Populus alba*, White Poplar. 1, shoot with male catkins; 2, shoot with female catkins; 3, shoot with fruiting catkins, 4, shoot showing lobed leaves; 5, shoot in winter; 6, seedling (H and W).

Populus tremula, L. Aspen (Fig. 86).

▱▱ *Catkins lax; scales glabrous or nearly so.*

§ *Capsule ovoid.*

Fig. 86. Aspen, *Populus tremula*. 1, dwarf shoots bearing a ♂ catkin; 2 and 3, ♂ flowers from below and in profile; 4, a ♀ catkin; 5 and 6, flowers from below and in profile; 7, capsule; 8, fruiting catkin; 9, dehiscing capsule; 10, seed; 11, foliage (Wi).

Populus nigra, L. Black Poplar (Fig. 87).

§§ *Capsule globoid.*

Fig. 87. *Populus nigra*, Black Poplar. 1, shoot with male catkins; 2, shoot with female catkins; 3, shoot with fruiting catkins; 4, seedling; 5, shoot in winter (H and W).

Populus canadensis, Desf. Canadian Poplar.

†† Fruiting catkins erect; scales, entire, velvety pubescent; capsules ovoid-conical.

⊙ *Scales of the catkin pale yellow or reddish, not dark at the tips.* [For (⊙ ⊙) see p. 89.]

▱ *Capsule glabrous.* [For (▱ ▱) see p. 89.]

§ *Capsule pedicellate.*

♯ *Catkin-scales persistent.*

Fig. 88. White Willow, *Salix alba.* 1, male catkin; 2, a male flower; 3, shoot with female catkin; 4, female flower; 5, fruiting catkin; 6, fruit with escaping seeds; 7, seed with its coma. 2, 4, 6 and 7, magnified (Sw).

Salix triandra, L. Almond Willow.

♯♯ *Catkin-scales caducous.*

÷ *Catkin-scales oblong.*

Salix pentandra, L. Bay Willow.

÷÷ *Catkin-scales linear-lanceolate.*

Fig. 89. Crack Willow, *Salix fragilis*. 1, male, and 2, female flowering shoot; 3, male, and 4, female flower, enlarged; 5, vertical section of latter; 6, ripe capsule; 7, seed (Wo).

Salix fragilis, L. Crack Willow (Fig. 89).

§§ *Capsule sessile or nearly so.*

♯ *Catkins about* 30—40 *mm. long; catkin-scales linear.*

Salix alba, L. White Willow (Fig. 88).

S. Russelliana, a hybrid between *S. alba* and *S. fragilis*, and the var. *vitellina* also come here.

♯♯ *Catkins* 4—6 *mm. long, few flowered; scales greenish yellow.*

Salix herbacea, L. Dwarf Willow.

▱▱ *Capsule tomentose-grey, sessile.*

Salix reticulata, L. Reticulate Willow.

⊙⊙ *Scales of the catkin brown or black, at least at the tip, persistent.*

▱ *Capsule glabrous.*

§ *Capsule sessile.*

Salix daphnoides, Vill. Violet Willow.

§§ *Capsule pedicellate.*

♯ *Catkins about* 15—25 *mm. long; scales linear oblong; pedicel of capsule slender.*

Salix nigricans, Sm. Black Willow. *S. phylicifolia*, L. Tea-leaved Willow. Not only is it impossible to distinguish *S. phylicifolia* and *S. nigricans* by the seeds and fruits, but the latter are often hairy (see p. 93).

♯♯ *Catkins* 50—100 *mm. long; scales oblong; pedicel short.*

Salix lanata, L.

▱▱ *Capsule hairy.*

§ *Capsule sessile or nearly so.*

♯ *Catkins sub-opposite.*

Salix purpurea, L. Purple Willow.

♯♯ *Catkins not opposite.*

÷ *Catkins* 20—25 *mm. long.*

Salix viminalis, L. Osier (Fig. 90).

÷ ÷ *Catkins* 25—75 *mm. long.*

Fig. 90. *Salix viminalis.* *A*, flowering male shoot (nat. size); *B*, male flower and bract (magn.); *C*, female inflorescence; *D–E*, female flowers (magn.); *F*, fruit (nat. size); *G*, fruit (magn.); *H*, seed (magn.) (Stras).

Salix Lapponum, L. Downy Willow.

§§ *Capsule pedicellate.*

ǂ *Capsule* 50—75 *mm. long.*

Fig. 91. Sallow, *Salix Caprea*. 1, apex of twig with ♂ catkins; 2, a ♂ flower; 3, base of same, showing gland of scale; 4, end of shoot with a ♀ catkin; 5, a ♀ flower; 6, stigma; 7 and 8, capsule closed and open; 9, seed; 10 and 11, buds; 12, leafy shoot (Wi).

Salix Caprea, L. Sallow, Goat Willow (Fig. 91). The var. *cinerea* usually has a shorter catkin.

‡‡ *Capsule not more than* 15—25 *mm. long.*

÷ *Catkin-scales pilose, tip black.*

8 *Catkin sessile.*

Fig. 92. Lilac, *Syringa vulgaris*. 1, leaf; 2, inflorescence; 3, flower; 4, upper part of the corolla in vertical section; 5, anther; 6, stigma; 7, ovary in vertical section; 8, capsule (Wo).

Salix aurita, L. Eared Willow.

8 8 *Catkin stoutly pedunculate.*

Salix Myrsinites, L. Whortle Willow.

÷÷ *Catkin-scales yellowish green or purple, with dark tip, silky.*

Salix repens, L. Creeping Willow.

Forms of *S. phylicifolia* and of *S. nigricans* with hairy capsules also come here (see p. 89).

** Capsule trigonal, 3-valved, in spikes not catkins.

Tamarix gallica, L. Tamarisk. The small, crowded, triangular and scale-like leaves, closely imbricated on slender feathery branches, at once distinguish this from the Willows.

(β) *Seeds of medium or large size, few, not comose.*

* Capsule woody, 2-valved; seeds about 4, bordered by a membranous wing.

Syringa vulgaris, L. Lilac (Fig. 92).

** Capsule with more than 2 valves; seeds not appreciably winged.

† Capsule very large[1], leathery, opening in 3 valves, and exposing one or two very large shining brown sub-globose seeds with broad hilum.

Æsculus Hippocastanum, L. Horse-chestnut. The coarsely prickly capsule of the Horse-chestnut must not be confounded with the densely prickly cupule of the Chestnut. The former is a true fruit of 3 carpels enclosing true seeds, with no trace of stigmatic or perigone scars: the latter is an accessory investment surrounding the true fruits, chestnuts, which bear traces of stigmas, &c. at their apex.

†† Capsule not large, with more than 3 valves.

[1] For a 3-valved capsule that is not very large and contains about six wingless seeds, see *Buxus* in the Appendix, page 154.

⊙ *Capsule 4-valved and 4 angular, soft and red; seeds pale brown, with brilliant orange arillus.*

Fig. 93. Spindle Tree, *Euonymus europæus*. 1, flowering shoot; 2, 3, flowers from above and below; 4, fruit; 5, the same in section; 6—8, seed whole and in section (Wi).

Euonymus europæus, L. Spindle Tree (Fig. 93).

⊙⊙ *Capsule woody, 5-valved; seeds numerous, small, not arillate.*

Rhododendron.

(b) **Fruit indehiscent and often seed-like.**

[The fruit characters of seed-like achenes are recognised in the presence of stigmatic scars, traces of perigones, more complex coverings, &c.]

(i) Fruit with only one seed. [For (ii) see p. 114.]

[Since the one-seeded condition frequently arises by abortion of one or more other ovules, exceptions may occur in which two seeds have reached maturity—e.g. *Tilia*.]

(*a*) *Fruit free of any accessory investing cupule.* [For (β) see p. 105.]

* Fruits shed from between the complex scales of a more or less elongated catkin. [For (**) see p. 97.]

† Catkin pendulous, cylindroid; its scales 3-lobed, tough, deciduous; fruits flat, winged, 2 mm. long, in threes.

Betula alba, L. Birch (Fig. 94). The scales of the catkin are composed of the bract and two bracteoles of the axillary group of three flowers, fused into a common trilobed whole (see Vol. III. p. 233); this and the indehiscent, one-seeded fruit, with a broad papery wing on each side, at once distinguish Birches from Willows and Poplars.

Betula nana, L. is similar, but the catkin and fruits smaller.

†† Fruiting catkins erect, woody, branched and cone-like, persistent; the scales more or less distinctly 5-lobed; achenes not winged, in pairs.

Fig. 94. Birch, *Betula alba*. 1, apex of branch with male (♂) and female (♀) catkins; 2, branch with a fruiting catkin, and, at the tip, young male catkins; 3—6, groups of ♂ flowers in front, lateral, upper and lower aspects; 6*, stamen; 7, portion of ♀ catkin; 8 and 9, groups of ♀ flowers from before and behind; 10, the scales of the latter; 11 and 12, fruiting scales; 13, fruit; 14, apex of shoot with young inflorescences; 15, transverse section of three-year-old branch (Wi).

Alnus glutinosa, L. Alder (Fig. 95). The beginner will have to be on his guard respecting the cone-like infructescences of *Alnus*.

The racemose branching of the pedunculate "cones," the complex nature of their scales, and the one-seeded, indehiscent achenes bearing scars or remains of stigmas, sufficiently distinguish them from true cones. Their being erect, woody, and persistent, and bearing achenes, at once distinguish them from Willows and Poplars; and the mere border to the achenes, in place of a distinct membranous winged margin, as well as their being in pairs, sufficiently differentiates them from the Birches, especially if the characters of the "cones" are borne in mind.

** Fruits not shed from between the scales of an elongated catkin.

† Fruits aggregated in globose heads. [For (††) see p. 101.]

⊙ *Fruit-heads (infructescences), sessile on pendent long stalks, deciduous and shedding the achenes (caryopsis) after falling; each achene wedge-shaped, with a tuft of hairs surrounding the pointed base.*

Platanus orientalis, L. (and *P. acerifolia*). The globose "button" is composed of the whole pistillate inflorescence, and is therefore an infructescence (multiple fruit) when it falls. There is no similar tree likely to be encountered, as *Platanus occidentalis* is exceedingly rare in Europe.

The comose seeds of *Tamarix*, Poplars and Willows are set free from the true fruits while these are still attached to the spikes or catkins as they hang from the tree; the superficially similar achenes of the Plane (*Platanus*) with their basal tuft of hairs may not fall

Fig. 95. Alder, *Alnus glutinosa*. 1, flowering shoot with young male and female catkins; 2, a male catkin; 3, one of the scales of the latter bearing three male flowers and their bracteoles, seen from outside; 4, the same in lateral view; 5, the same from inside; 6, the same from above; 7, a single male flower from outside, and 8, from inside; 9, a female

catkin ; 10, one of its scales bearing two female flowers, seen separately in 11 ; 12—14, fruiting scales seen from above, from below and from the front; 15, 16, the fruit whole and in section; 17, ripe cone-like fruiting catkins ; 18, one of the cone-like catkins after shedding its fruits ; 19, a twig; 20, section of branch (Wi).

Fig. 96. *A*, shoot of *Platanus occidentalis* ; *a*, male, and *b*, female flowers; *n*, stipules ; *B*, female flower magnified ; *C*, male flower with stamens removed ; *D*, floral diagram, theoretical ; *E*, ovary ; *F*, ovary in section ; *G*, fruit (caryopsis) ; *H*, glandular hair ; *J* and *K*, ordinary hairs of leaf ; *L* and *M*, hairs at base of fruit (E and P).

out from the globular infructescence before the latter has fallen to the ground.

⊙⊙ *Fruit-head an æterio of achenes, each terminated by a long plumose style.*

Fig. 97. Traveller's Joy, *Clematis Vitalba* (Sch).

Clematis Vitalba, L. Traveller's Joy, Old Man's Beard (Fig. 97). The globoid æterio here consists of the results

of fertilization of a single flower, the apocarpous pistils of which have developed into achenes, each topped by the persistent style that has grown out into a plumose filament. The only similar arrangement in our flora exists in certain herbaceous Anemones and Potentillas.

†† Fruits not aggregated in heads, catkins, &c.

⊙ *Fruit a samara, winged by forward or lateral prolongation of the carpel into a membrane.* [For (⊙⊙ see p. 103

▱ *Wing long and narrow, prolonged forwards only, with the seed at its base.*

Fraxinus excelsior, L. Ash (Fig. 18). Winged fruit about 40 × 8 mm.; the wing leathery, smooth, tawny, cuneate-oblong rounded above, with numerous more or less parallel veins; seed nearly half as long as the whole fruit, flat, cuneate-oblong, longitudinally striate. Pedicel and remains of floral axis present at the base.

▱▱ *Wing prolonged in more than one direction, with the seed near the middle.*

§ *Wing elongated, asymmetrical, notched on one side near the middle.*

Ailanthus glandulosa, Desf. Tree of Heaven (Fig. 19). The fruit is about 25 × 10 mm. long, flat, thin, tawny, and irregularly oblong and veined: the lateral notch is due to lack of growth at the point of attachment of the seed. The wing is usually twisted above. Each flower gives rise to several, about three, fruits.

§§ *Wing broad oval to sub-orbicular, notched at the top; remains of perigone persisting below.*

♯ *Seed in the middle of the broadly oval samara.*

Ulmus montana, Sm. Wych Elm (Fig. 98). Fruit

smooth, greenish grey, broadly oval or sub-orbicular, 15—30 mm. long; the sides of the usually deep notch

Fig. 98. *Ulmus montana*, Wych Elm. 1, flowering shoot; 2, fruiting shoot; 3, seedling; 4, shoot in winter; *k*, vegetative buds; *b*, inflorescence-buds (H and W).

often crossing over in two curved hooks; the wing is netted. The green samaras frequently hang on the trees in tufts so dense as to give the trees an appearance of green before the foliage is out.

♯♯ *Seed above the centre of the obovate samara.*

Fig. 99. Elm, *Ulmus campestris*. 1, flowering shoot; 2, twig of the preceding year, with tuft of fruits and a dwarf shoot bearing foliage; 3, a flower; 4, ovary; 5, fruit; 6—8, seeds; 9, buds (Wi).

U. campestris, Sm. Elm (Fig. 99). Samara about 15—20 mm. long.

⊙⊙ *Fruit not a samara, and not itself winged. Common peduncle of the infructescence fused to a long membranous bract.*

Tilia europæa, L. Lime (Fig. 100). The fruits are globoid and nut-like (*carcerulus*), pedicellate on a common peduncle, with the linear-oblong bract adherent for half

Fig. 100. *Tilia europæa*, Lime. 1, flowering shoot; 2, fruitin shoot; 3, fruit; 4, seedling; *k*, cotyledons; 5, shoot in winter (H and W).

its length; each one-seeded by the abortion of the other 4 cells and their pairs of ovules, or occasionally 2 seeds ripen. It is superior, with traces of the stigma above, and of perianth, &c. below, slightly ribbed, about 10 mm. long, and grey velvety, splitting on germination.

The var. *parvifolia* has a somewhat smaller, smoother, and less evidently ribbed fruit than the var. *grandifolia*, and is slightly reddish, also more easily crushed, owing to thinner walls.

(β) *Fruits nut-like, enveloped more or less completely in a cupule or enveloping bracts.*

* Seed-like nut small, 5—10 mm. long, longitudinally ribbed, and incompletely surrounded below by a large foliaceous trifid wing-like bract.

Carpinus Betulus, L. Hornbeam (Fig. 101). The fruit-like characters are visible in the crown of perigone-remnants and stigmas above. The nut is very hard, smooth and ribbed. The adherent cupular bract acts as a wing.

** Nuts large and heavy, not ribbed, completely invested at least below by a cupule which is not wing-like.

† Cupule widely open above, and exposing the single ovoid round nut. [For (††) see p. 111.]

⊙ *Cupule more or less hemispherical, and cup- or basin-shaped, embracing the single ovoid nut (acorn) at the base.* [For (⊙⊙) see p. 111.]

▱ *Cupule covered with numerous imbricated scales, which are broad, triangular, appressed.* [For (▱▱) see p. 111.]

§ *Cupule hemispherical or turbinate and embracing the acorn some distance up.* [For (§§) see p. 110.]

Fig. 101. Hornbeam, *Carpinus Betulus*. 1, flowering shoot with two male catkins below and a female catkin above; 2, a fruiting catkin; 3, scale of male catkin from in front; 4, the same from the side, and 5

from inside, showing the stamens, of which two are also seen separated and viewed from behind and from the front; 6 and 7, pair of female flowers enveloped in their bracts and bracteoles; 8, a separated female flower; 9, fruits and cupule; 10, fruits; 11, the fruit in section; 12, seeds; 13, buds; 14, seedling (Wi).

Fig. 102. Sessile-flowered Oak, *Quercus Robur*, var. *sessiliflora*. 1, flowering shoot, the ♀ flowers in the uppermost leaf-axils; 2, apex of branch with the sessile acorns; 3, a female flower; 4, portion of ♂ catkin (Wi).

Fig. 103. Pedunculate Oak, *Quercus Robur*, var. *pedunculata*. 1, flowering shoot; 2, apex of branch with pedunculate acorns; 3, portion of ♂ catkin; 4, stamen, and 5, transverse section of anther; 6, female flower; 7, the same in section; 8, twig with buds (Wi).

‡ *Cupule with few and broad scales almost or quite glabrous, hemispherical; acorn smooth, shining.*

Quercus Robur, L. Oak (Figs. 102, 103). The narrow oblong acorn shows the remains of the stigma and minute traces of the perigone at its duller apex, and varies in length from about 20 to 40 mm. Occasionally two or more seeds may occur in the fruit, and the remains of aborted ovules at the base betray the fact that it (the acorn) was primarily a 3-chambered ovary with 2 ovules in each chamber.

[Two principal varieties are distinguished, *Q. pedunculata* (Fig. 103), with the acorns scattered and on evident peduncles, and *Q. sessiliflora* (Fig. 102) with sub-sessile acorns more crowded on a condensed peduncle.]

‡‡ *Cupule turbinate or somewhat conical, with small triangular scales, grey tomentose, as is also the acorn.*

Fig. 104.

Fig. 105.

Fig. 104. *Quercus Ilex*, acorn (Kotschy).
Fig. 105. *Quercus Suber*, acorn (Kotschy).

Quercus Ilex, L. Evergreen Oak, Holme Oak (Fig. 104).

The co-existence of the evergreen leaves renders this tree easy of recognition from all but *Q. Suber*.

§§ *Cupule shallow, saucer-shaped, hardly embracing the acorn.*

Fig. 106. Turkey Oak, *Quercus Cerris* (Sc).

Quercus rubra, L. Red Oak. The acorn is broad and short, about 15 mm. long, and almost dome-shaped, sitting

with an expanded base in the shallow cup; it is pale brown, longitudinally striated, smooth as are the scales of the cupule. That of *Q. coccinea* is very similar.

▱▱ *Cupule-scales long, narrow, spreading, and hairy.*

§ *Acorn smooth, cup hemispherical, with fimbriated scales.*

Quercus Cerris, L. Turkey Oak, Mossy-cupped Oak (Fig. 106).

§§ *Acorn velvety, half submerged in the conical cup.*

Quercus Suber, L. Cork Oak (Fig. 105).

⊙⊙ *Cupule tubular of foliaceous aspect, fimbriated at the free margins, which project beyond the top of the enclosed nut.*

Corylus Avellana, L. Hazel (Fig. 107). The Hazel-nut has a hard woody shell, and exhibits traces of the fused perigone margin near the apex: it occasionally contains 2 kernels, but as a rule one of the two ovules aborts.

†† Cupule closed above until maturity, then opening by 4 valves and disclosing 2—3 more or less angular nuts.

⊙ *Nuts* 2, *sharply trigonal; cupule stiff, almost woody, covered with soft blunt prickles.*

Fagus sylvatica, L. Beech (Figs. 108, 109). Each nut is about 12·5 mm. long and shows traces of perigone and stigmas at the apex, and is shining, smooth, brown, with a triangular scar of attachment. As a rule it contains only one seed, in which the cotyledons and first leaves are peculiarly folded; the other two chambers and 5 ovules being aborted.

Fig. 107. Hazel, *Corylus Avellana*. 1, twig with ♂ and ♀ flowers; 2, leaf and nearly ripe fruits; 3, scale, bearing ♂ flower; 4, a stamen; 5, female flower invested by the young involucre; 6, sections through ovary; 7, 8, nuts; 9, 10, kernel (embryo) (Wi).

Fig. 108. Beech, *Fagus sylvatica*. 1, shoot with a group of ♀ flowers above, and ♂ catkins below; 2, a male flower; 3, stamens, and trans-

verse section of anther ; 4, two female flowers in their cupule ; 5, ovary, advancing towards maturity ; 6 and 7, the same in section ; 8, fruits exposed by the splitting of the cupule into four valves ; 9, the same before splitting ; 10, seed in section ; 11 and 12, buds (Wi).

Fig. 109. Beech, *Fagus sylvatica*. 3, vertical section through female inflorescence ; 5, ripe fruit showing between the valves of the cupule (Wo).

⊙⊙ *Nuts with rounded angles or plano-convex, in 3's in the cupule, which is densely beset with stiff sharp prickles.*

Castanea vesca, L. Chestnut (Fig. 110). Nut about 20—35 mm. long, with a red-brown, smooth, shining leathery pericarp, and a large paler oval scar of attachment, and showing silky hairs at the base and at the pointed, somewhat attenuated, apex, where remains of stigmas and perigone may be found. The seed is reduced to one from an ovary with about 6 chambers containing 2 ovules each.

[In regard to possible confusion with *Æsculus* see p. 93.]

(ii) Fruit 2-seeded and 2-winged ; a double samara, each half with one seed and a spreading lateral more or less obliquely expanded wing.

(*a*) *Wings extended at nearly a right angle to the plane of junction of the two halves,*

and of nearly equal breadth at the base and apex; body of fruit pubescent.

Acer campestre, L. Maple (Fig. 21). Wing glabrous, except at the seed-vessel proper, which is more or less pubescent; the latter very hard and tough, silvery shining

Fig. 110. Chestnut, *Castanea vesca*. 1, flowering shoot; 2, vertical section through cluster of female flowers in their involucre; 3, transverse section of ovary; 4, a male flower; 5, fruits in their involucre (Wo).

inside; seed flattened, embryo green and plaited. Wing linear oblong and slightly curved, obliquely acute, reticulate, about 30—40 mm. long.

Fig. 111. Norway Maple, *Acer platanoides*. 1, flowering shoot; 2, hermaphrodite flower, after removal of calyx and corolla; 3, male flower, similarly treated; 4, ovary; 5, fruit; 6, opened fruit; 7, seed; 8, the same in section; 9, leaf; 10, buds (Wi).

Fig. 112. Sycamore, *Acer Pseudo-Platanus*. 1, flowering shoot; 2, hermaphrodite flower; 3, the same after removal of the sepals and petals; 4, male flower seen from above; 5, ovary, with the left cell opened; 6, transverse section of ovary; 7, fruit; 8, the same opened and exposing the seed *x*, *y*; 9, seed in section across *a*, *b* in 10; 10, embryo; 11, buds; 12, seedling (Wi).

(β) *Wings extended forwards, at an angle with the line of junction: all glabrous.*

* Wings extended at an angle of 45°, or more, not constricted where they leave the seed-chamber.

A. platanoides, L. Norway Maple (Fig. 111).

The chief difference from *A. campestre* lies in the angle of divergence of the wings, their greater breadth near their middle, and larger size, each being about 55—60 mm. long.

** Wings extended forwards at an angle of 15° or so, strongly constricted below and expanded above.

A. Pseudo-Platanus, L. Sycamore (Fig. 112). The distinctive points from the other two species are that the wings are more constricted below and more expanded above and directed forwards at a smaller angle.

(2) Fruit fleshy, with watery or viscid juice, indehiscent.

[For (2**) see p. 151.]

(2*) Fruit simple, not aggregate nor multiple.

[For (b) see p. 137.]

(a) **Fruit drupaceous, a "stone fruit"; the seed protected by a hard bony endocarp or shell.**

[For (ii) see p. 127.]

(i) Drupe with one stone only.

[For (β) see p. 122.]

(*a*) *Drupe superior; with no trace of perigone or stamens at the apex.*

[For (**) see p. 121.]

* Drupe 10 mm. or more in diameter, smooth, with no hairs nor other appendages on its surface.

[For (††) see p. 121.]

† Ripe fruit blue-black or purple black.

[For(⊙ ⊙) see p. 121.]

⊙ *Ripe fruit glaucous with waxy-bloom.*

▱ *Drupe globoid, solitary, about* 15 *mm. long; flesh green, very astringent.*

Prunus spinosa, L. Blackthorn (Fig. 113). The sharp astringency disappears after frosting. Stone hard, slightly flattened, about 10 × 8 × 5 mm., with irregular furrows and ridges; kernel ovate pointed, with a velvety skin, 6 × 4 mm.

P. insititia has a similar fruit, with sweeter flesh.

▱▱ *Drupe oblong, slightly compressed and grooved down one side, about* 40—50 *mm. long; flesh sweet.*

Fig. 113. Blackthorn, *Prunus spinosa*. 1, flowering shoot; 2, fruiting branch; 3, flower in vertical section, enlarged; 4, fruit in section (Wo).

Fig. 114. Bird Cherry, *Prunus Padus*. 1, flowering shoot; 2, fruiting raceme; 3, flower in vertical section, the petals removed (Wi).

Prunus spinosa, var. or sub-sp. *domestica*. The stone is compressed, more or less ovoid-acute with one edge sharp the other furrowed, about 25 × 15 mm., and containing a kernel about 12 × 5 mm.

⊙⊙ *Ripe fruit not glaucous with bloom, globoid, 10 mm. or so in diameter, in pendulous racemes.*

Prunus Padus, L. Bird Cherry (Fig. 114). Flesh bitter. Stone with a deep furrow and a net-work of pits in the shell, 7—8 × 5—6 mm.; seed yellow.

P. Laurocerasus and *P. lusitanica* have similar fruits on stiff erect racemes.

†† Ripe fruit red to red-black, with no bloom, globose, about 12—15 mm. diameter, pendent on long stalks in tufts of 2—3.

P. Cerasus, L. Cherry (Fig. 22). Flesh acid-sweet. Stone smooth and rounded, 10 mm. long.

P. Cerasus, var. or sub-sp. *Avium*, differs in little but its deeper colour and more bitter taste.

The fruits of *Rubus* (Blackberry, Raspberry, &c.) are merely aggregates of small drupes, drupels, each with its own minute single stone, collected into a common head (see p. 152).

** Fruit not more than 5 mm. in diameter, and bearing hairs or other appendages; false drupes of more than one carpel.

† Drupe covered with red hairs, globoid-compressed, about 5 mm. in diameter.

Rhus typhina, L. Sumach. Stone tender, seed recumbent.

Amygdalus, the Almond (Fig. 115), also comes here. The drupe is ovoid, slightly compressed, with a somewhat dry tough pericarp, which may split as the fruit matures,

velvety-tomentose and about 40 mm. long. The endocarp is fibrous, woody, and much pitted, containing the well-known almond kernel.

†† Drupe very small, 2—3 mm., with 2 lateral wing-like appendages, waxy and odorous.

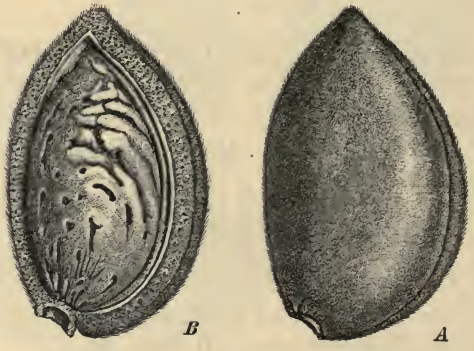


Fig. 115. *Prunus Amygdalus*. *A*, fruit. *B*, fruit opened to expose the stone (E and P).

Myrica Gale, L. Sweet Gale, Bog Myrtle (Fig. 116). The fruits are solitary in the axils of the scales of small erect catkins, and each results from the maturity of a bicarpellary ovary to which the two bracteoles adhere as wing-like out-growths.

(β) *Drupe inferior, crowned with remains of perigone, stamens, &c.*

[For (††) see p. 127.]

† Fruit rounded oblong or ovoid, not compressed.

⊙ *Drupe large, ovoid-oblong, about* 50 × 30 *mm., with smooth olive exterior, glandular-punctate and aromatic, rapidly blackening when bruised, and containing the well-known walnut.*

Juglans regia, L. Walnut (Fig. 117). The pericarp abounds in tannin: the shell (endocarp) is grooved and pitted irregularly and splits into two halves down the

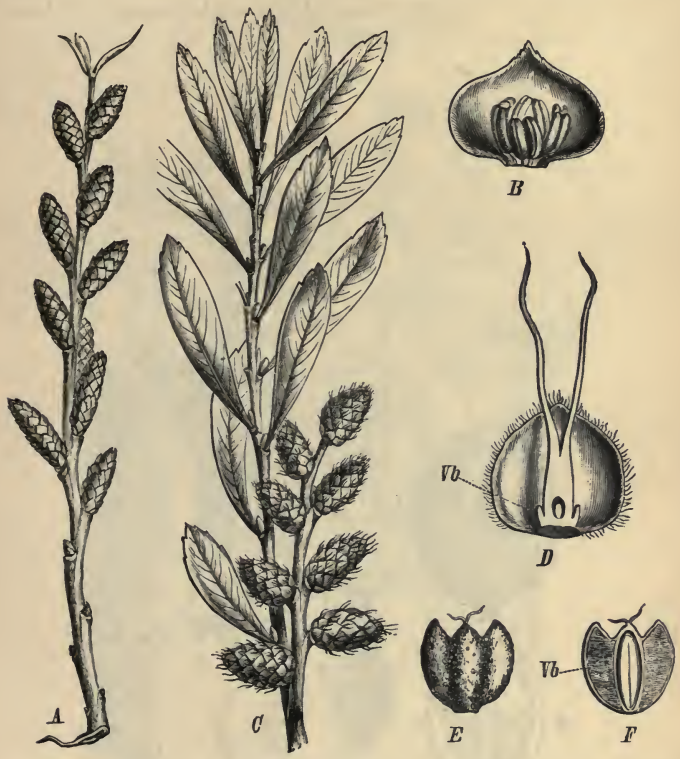


Fig. 116. Sweet Gale, *Myrica Gale*, L. *A*, shoot with ♂, and *C*, with ♀ catkins; *B*, scale with ♂ flower; *D*, scale with ♀ flower, the latter in section; *E*, fruit with its two fused lateral bracteoles; *F*, the same in section (E and P).

midrib of the carpel; each half, divided into two compartments by a thin septum, complete below. Embryo

large and oily, consisting chiefly of the corrugated cotyledons.

⊙⊙ *Drupe small, 8—12 mm. long, bright-coloured and softly fleshy.*

▱ *Drupe oblong, golden orange with brown spots.*

Fig. 117. Walnut, *Juglans regia*. 1, flowering shoot, bearing *a* a male catkin and *b* a female inflorescence; 2, male flower with *a* a stamen seen from within, *b* one from the side; 3, female flower; 4, vertical section of same; 5, fruit with one half removed; 6, vertical section through the nut; 2, 3 and 4 enlarged (Wo).

Hippophaë rhamnoides, L. Sea Buckthorn (Figs. 118 and 119). The fruit results from one carpel immersed in the calyx-tube; the former becomes the stone containing

Fig. 118. Sea Buckthorn, *Hippophaë rhamnoides*. Fruiting branches (Sc).

the seed, the latter the yellow-fleshed, watery covering. Stone brown, 4—5 mm. long, smooth and shining, ovoid.

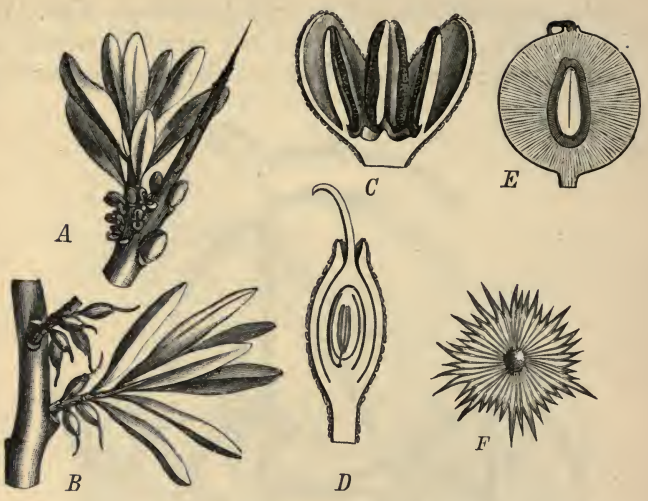


Fig. 119. Sea Buckthorn, *Hippophaë rhamnoides*. *A*, ♂, and *B*, ♀ flowering shoots; *C*, ♂, and *D*, ♀ flower in longitudinal section; *E*, fruit in vertical section; *F*, one of the peltate scales (E and P).

Daphne Mezereum, L. (Fig. 120) with a red, very poisonous 1-stoned inferior drupe comes here.

▱▱ *Drupe globoid, shining red, with a flat cordate stone.*

Viburnum Opulus, L. Guelder Rose (Fig. 121). The berry-like fruit, 8—12 mm. in diameter, has watery juice, and contains a flat, brown, ovate-rotund stone, pointed above and cordate at the base, 8—10 × 3—4 mm.

Perhaps *Cornus sanguinea*, L. which has only one stone but encloses two seeds, should come here: the fruits are black. See p. 133.

Cratægus Oxyacantha, L. sometimes has but one stone in the red hypanthium; in that case it may be looked for here (see p. 134).

†† Fruit laterally compressed, ovoid, with yellow, dryish, and friable flesh.

Viburnum Lantana, L. Wayfaring Tree. Fruit passing through red to nearly black as it ripens, 8—10 mm. long, with evident remains of calyx and stigmas as a thick cushion above. Stone yellow, longitudinally striped, flat, 7—8 mm. Pedicels of the cymes scurfy.

Fig. 120. Mezereon, *Daphne Mezereum*. 1, flowering shoot; 2, vertical section of flower enlarged; 3, fruiting branch (Wo).

(ii) Drupaceous fruits with more than one stone and relatively thin flesh; more or less globoid and smooth, berry-like, 6—12 mm.

[The only essential difference from true berries lies in

Fig. 121. Guelder Rose, *Viburnum Opulus*. 1, flowering shoot; 2, a barren, and 3, a hermaphrodite flower; 4, portion of fruiting cyme; 5 and 6, kernel in vertical and transverse section (Wi).

the relatively thin flesh and the bony coverings of the seeds as a prominent feature: see p. 25–6.]

(*a*) *Fruit superior, not crowned by remains of perigone, &c.* [For (*β*) see p. 132.]

* Fruit ovoid, scarlet, 10—12 mm. long, with 4 stones.

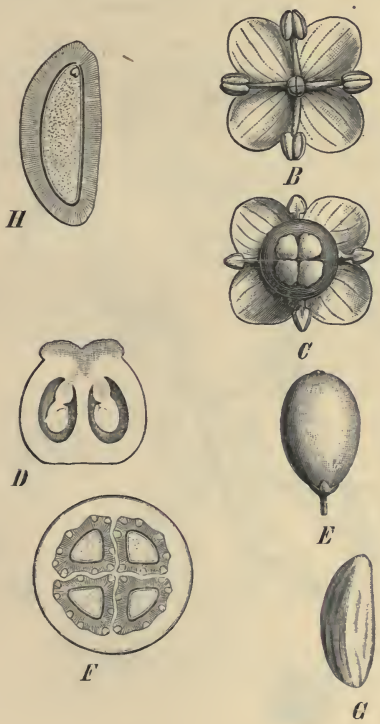


Fig. 122. Holly. *B*, a ♂ flower; *C*, a ♀ flower; *D*, longitudinal section of ovary, showing the pendent ovules; *E*, fruit; *F*, the same in transverse section; *G*, seed; *H*, the same in longitudinal section (E and P).

Ilex Aquifolium, L. Holly (Fig. 122). Fruit, "holly berry," ovoid, about 10—12 mm. long, with 4 one-seeded, free, erect, bony, furrowed, yellowish stones, each long and angular. Stigmatic scar at apex, and remains of 4 sepals below. It is derived from a 4-chambered ovary with 1 ovule in each chamber.

** Fruit black, globose, 5—8 mm. in diameter, with 3 or 4 stones.

† Fruit brown-black; stones 3, flat, lenticular, with ridges and a pale brown knob on one flat side.

Fig. 123. Alder Buckthorn, *Rhamnus Frangula*. 1, flowering shoot; 2, flower; 3, the same in vertical section; 4, fruit; 5, seed. 2 and 3, enlarged (Wo).

Rhamnus Frangula, L. Alder Buckthorn (Fig. 123). The globular drupe passes through dark brown to black, and has very thin flesh.

†† Fruit blue-black; stones 4, obovoid, angular, grooved at the back.

R. catharticus, L. Buckthorn. Easily confounded by a beginner with *Prunus spinosa* until attention is directed

Fig. 124. Ivy, *Hedera Helix*. 1, flowering shoot; 2, leaf of a barren climbing shoot; 3, flower in vertical section, enlarged; 4, floral diagram; 5, fruit; 6, seed (Wo).

to the several stones, and the sub-opposite arrangement of the leaves and spines: the persistent calyx-tube at the base is also a useful character.

(β) *Fruit inferior, the remains of perianth, stamens, &c. forming a crown at the apex.*

Fig. 125. Dogwood, *Cornus sanguinea*. 1, flowering shoot; 2, buds; 3, flower; 4, the same enlarged, after removal of petals and part of style; 5, part of a fruiting cyme; 6, fruit in vertical section (Wi).

* False drupe black, sub-globoid, 6—8 mm. long, and containing 2—5 seeds.

† Fruits dull black-olive in simple umbels, with 2—5 seeds in as many parchment-like cells.

Hedera Helix, L. Ivy (Fig. 124).

Sambucus, with usually 3 stone-like seeds in the berry, may also be looked for here.

†† Fruit black, shining, in corymbose-cymes, with one 2-chambered stone, containing two seeds.

Cornus sanguinea, L. Dogwood, Cornel (Fig. 125). The fact that there is but one common stony covering to the two seeds suggests that it should go on p. 126 near *Viburnum Opulus*.

** False drupe scarlet or crimson, 7—10 mm. long, and containing 2—5 seeds.

† Fruit globoid, 6—7 mm. long. Fleshy covering (hypanthium) open above, exposing the tips of the 2—5 stones in a crater bordered by the remains of the sepals and stamens.

Cotoneaster vulgaris, Lindl. Cotoneaster. The fruits proper are the stones, each of which is developed from one carpel; around these the calyx-tube has risen as a fleshy cup, bearing the sepals and stamens on its margin, and forming the globoid, mealy-fleshy false fruit (hypanthium).

†† Fruit globoid, 10 mm. Fleshy covering closed in over the usually 2 stones.

Cratægus Oxyacantha, L. Hawthorn, Whitethorn (Fig. 126). The mode of development is as in *Cotoneaster*, but the calyx-tube closes in more completely above, carrying the sepals and stamens to the top. Flesh and stones yellowish,

the former somewhat mealy, the latter hard, feebly sulcate, flat inside, convex outside, and about 7 × 5 mm. In the var. *C. monogyna* there is but one stone (see p. 126).

Fig. 126. Hawthorn, *Cratægus Oxyacantha*. 1, flowering shoot; 2, fruit; 3, section across latter (Wo).

The scarlet "hip" of *Rosa*, the Rose (Fig. 127), may be placed here, though it differs somewhat in detail. The ellipsoidal, orange-fleshy, urceolate receptacle is about 50—60 mm. long, scarlet-crimson and polished, and encloses in its hair-lined cavity about 20—25 achenes or "stones," equivalent to the "stones" more closely embraced in the flesh of the "haw" of *Cratægus*. Each achene is 7—8 mm. long, angular, yellowish and hairy, and has a long style passing up through the aperture of the receptacle.

The false drupe of *Juniperus communis*, L., the Juniper (Fig. 128), may also be placed here, though it is really a fleshy cone (Galbulus) with the seeds between the fused scales. The brownish-black "berry," covered with bluish waxy bloom, is sub-globoid, 6—8 mm. long, and marked at the upper part with three triangular projections, the tips

Fig. 127. Dog Rose, *Rosa canina*. 1, flowering shoot; 2, flower in vertical section; 3, the hip, and 4, the true fruit; 5, the latter in section; 6, floral diagram (Wo).

of the upper fused scales, which must not be confounded with remains of perigone, stigma, &c.; at the base are a few scarious scales, again not to be confounded with a perianth. Immersed in the fleshy mass formed by the confluent 1—2 whorls of three scales each, are 3 ovoid-

Fig. 128. Juniper, *Juniperus communis*, L. Shoots with ♂ and ♀ flowers. *a* a ♂ flower; *b* and *c* stamen seen from above and from below; *d* pollen; *e* a ♀ flower; *f* the three ovules with the subtending carpellary scales; *g* transverse section of the same; *h* the "berry" (*galbulus*) in section; *i* seed; *k* the same in section (B and S).

angular, hard-shelled seeds, each with several resin-blisters on it. The whole presents striking, superficial resemblances to an inferior false-drupaceous fruit, until attention is paid to the details. Each galbulus is sub-sessile on branches bearing whorls of three subulate evergreen leaves.

(b) **Fruit a berry or of berry-like nature (baccate), with small seeds immersed in relatively large pulpy flesh, and not conspicuous as "stones."**

[The essential difference from the drupe is that the pericarp is fleshy throughout, or at most parchment-like

Fig. 129. Gooseberry, *Ribes Grossularia*. 1, flowering shoot; 2, flower in vertical section, enlarged; 3, transverse section of fruit; 4, vertical section of seed (Wo).

inside, any hard shell to the seed being due to the seed-coats; but in practice any such fruit is called a berry where relatively small seeds are immersed in a copious pulp.]

(i) Berry inferior, bearing the scars of sepals, stamens, &c. at its apex. [For (ii) see p. 147.]

[For (β) see p. 141.]

(*a*) *Berry with thin tough skin; flesh, including the endocarp, pulpy throughout.*

* Berry rounded and not divided into chambers; not exceeding 25—30 mm. long.

† With several small seeds. (True Berries.)

⊙ *Berry oblong-globoid, hairy,* 15—30 *mm. long, yellowish.*

Ribes Grossularia, L. Gooseberry (Fig. 129). There is a glabrous-fruited variety.

⊙⊙ *Berry globose, smooth, not more than* 7—8 *mm. in diameter.*

▱ *Berry red, acid.*

Ribes rubrum, L. Red Currant.

▱▱ *Berry black, mawkish.*

Fig. 130. *Aucuba japonica.* *A*, shoot bearing male flowers; *B*, a male flower magnified; *C*, an inflorescence of female flowers; *D*, a female flower magnified; *E*, ovary, and *F*, fruit in longitudinal section (E and P).

Ribes nigrum, L. Black Currant.

†† Berry with one seed only, opaque, scarlet.

Aucuba japonica, Thunb. Garden Laurel (Fig. 130).

Viscum album, L. (Fig. 131), with a greenish-white, globular, very viscid, false berry, about 10—12 mm. diameter, also comes here: it has one seed only.

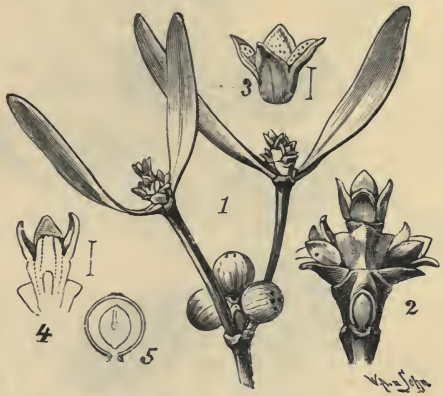


Fig. 131. Mistletoe, *Viscum album*. 1, shoot of female plant, bearing flowers and fruit; 2, group of flowers; 3, a male flower; 4, section of flower; 5, section of fruit (Wo).

** Berry divided into 2—5 chambers, each with one or more seeds.

† Berry snow-white, flesh somewhat dry and friable; two-chambered and two-seeded.

Symphoricarpos racemosus, Mchx. Snowberry (Fig. 132).

†† Berry not white, but brilliant red.

⊙ *Berries in pairs, joined at the base.*

Lonicera Xylosteum, L. Fly Honeysuckle.

⊙⊙ *Berries not in pairs.*

▱ *Heads of berries sessile in axils of perfoliate leaves.*

Fig. 132. *Symphoricarpos racemosus.* *a*, flowering shoot ($\frac{1}{3}$); *b*, flower with corolla opened; *c*, unripe fruit; *d*, ripe fruit (Döbner and Nobbe).

Lonicera Caprifolium, L. Perfoliate Honeysuckle (Fig. 133).

▱▱ *Heads of berries pedunculate.*

Fig. 133. Perfoliate Honeysuckle, *Lonicera Caprifolium*. 1, flowering shoot; 2, floral diagram; 3, ovary in vertical section; 4, cluster of fruits (Wo).

Lonicera Periclymemum, L. Honeysuckle, Woodbine.

(β) *Baccate fruits not pulpy throughout, but with tough cartilaginous or parchment-like linings to the seed-chambers.*

* Berry purple black, containing 3—5 seeds in as many cells protected by a thin cartilaginous endocarp.

Sambucus nigra, L. Elder (Fig. 134).

It is not easy to classify the elder-berry. Morphologically it resembles the berries of *Lonicera*, *Symphoricarpos*, &c., being an inferior 3—5-chambered fruit with

Fig. 134. Elder, *Sambucus nigra*. 1, flowering shoot; 2, flower in vertical section, enlarged; 3, fruit; 4, floral diagram (Wo).

one seed in each chamber, but the lining-walls of the chambers become brittle, white and nearly bony, so that the fruit is often termed a baccate-drupe. It is globose, shining, purplish-black, soft and aromatic, 5—6 mm. in diameter and marked above with the perigone remnants.

** Fruits not black.

† Flesh firm, fruit 25—50 mm., or more, long, with 5 cells lined with a thin cartilaginous endocarp (Pome).

⊙ *Pome sub-globose, indented at the base.*

Pyrus Malus, L. Apple, Crab (Fig. 135). Stalk usually short and seeds pale brown.

⊙⊙ *Pome not indented at the base, often pyriform and more or less tapering at the base.*

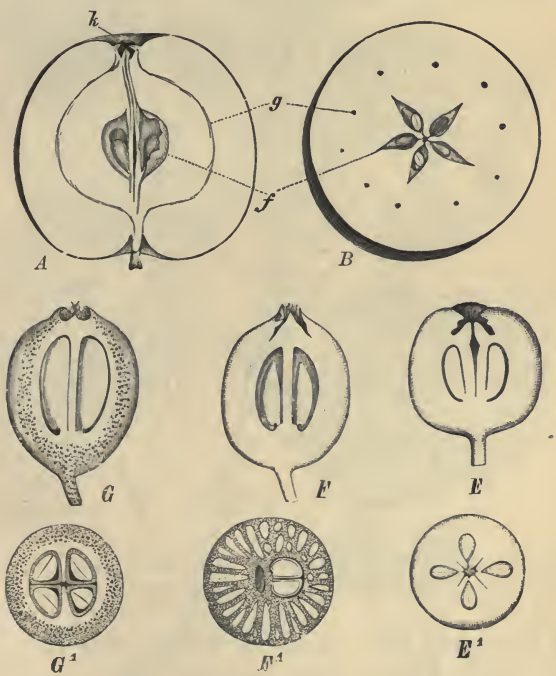


Fig. 135. *A*, *B*, Apple, showing five carpels, *f*, embedded in fleshy calyx-tube; *E*, *E*¹, Rowan, showing four carpels; *F*, *F*¹, White Beam Tree, showing obliteration of all but one of the carpels as the fruit ripens; *G*, *G*¹, Service Tree, showing four carpels (E and P).

P. communis, L. Pear (Fig. 136). Stalk usually long and seeds deep brown.

†† Flesh soft or mealy, fruit not longer than 10—20 mm., endocarp brittle.

⊙ *Pome olive-brown with grey dots; pyriform or sub-globular, 2-celled.*

Fig. 136. Pear, *Pyrus communis.* 1, flowering shoot; 2, vertical section of flower; 3, fruit in section; 4, floral diagram (Wo).

P. torminalis, Ehr. Wild Service-tree (Fig. 137). The fruit is about 15 mm. long, crowned by the remains of stamens, calyx, &c.; the flesh becomes brown and almost friable after bletting by frost. The peculiar whitish-grey dots on the fruit are lenticels.

⊙⊙ *Pome red, not pyriform, globoid.*

▱ *Pome dull red, slightly dotted,* 15—20 *mm. in diameter.*

Fig. 137. Wild Service-tree, *Pyrus torminalis*, piece of ordinary foliage twig, and two fruits (Sc).

Fig. 138. Beam Tree, *Pyrus Aria*. 1, fruiting branch; 2, flowers; 3, a flower in vertical section, after removal of the sepals; 4, fruit in vertical section (Wi).

Pyrus Aria, Ehr. Beam-tree, White Beam (Fig. 138).

▱▱ *Pome brilliant coral-red or scarlet, smooth, 10 mm. in diameter.*

P. Aucuparia, Ehr. Rowan, Mountain Ash (Fig. 139).

Fig. 139. Rowan, *Pyrus Aucuparia*. Fruiting branch (Sc).

(ii) Berry superior, only with a stigmatic scar at apex.

(*a*) *Berry oblong, orange-scarlet or yellow.*

* Berry narrow oblong, with 1—2 seeds.

Berberis vulgaris. Barberry (Fig. 140). The narrow oblong, slightly compressed and curved berry is about 10—12 mm. long, with an acid taste, and consists of one carpel only. The perianth is deciduous.

** Berry ovoid-oblong, with cup-like calyx below; seeds numerous.

Fig. 140. Barberry, *Berberis vulgaris.* 1, flowering shoot; 2, flower in vertical section, enlarged; 3, a petal; 4 and 5, a stamen; 6, fruit (Wo).

Lycium barbarum [so-called, but in reality *L. chinense*, Mill.], misnamed the Tea-tree (Fig. 141).

(*β*) *Berry globose.*

* Berry rough with small warty excrescences, red; flesh rather dry and friable; seeds numerous.

Arbutus Unedo, L. Strawberry-tree. The fruit has

been termed a dry berry; it has 5 cells, each with 4—5 seeds which are angular and coriaceous. When ripe the

Fig. 141. *Lycium chinense* (so-called *L. barbarum*). *a*, flowering shoot ($\frac{1}{2}$). *b*, flower. *c*, fruit. *d*, labiate calyx. *e*, five-toothed calyx (Döbner and Nobbe).

fruit, about 15—18 mm. in diameter, bears a superficial resemblance to a strawberry in shape, size and colour.

Fig. 142. Vine, *Vitis vinifera*. 2, flower casting the petals as a cap; 3, vertical section of flower; 4, ditto of fruit; 5, seed (Sc).

It is hardly necessary to say that aggregate fruits like the blackberry are totally different in structure.

** Berry quite smooth; purple to blue-black, and few seeded.

† Ripe berries with waxy bloom, purple.

⊙ *Berry with a ring-like disc at its base. Seeds 2—4 in soft flesh, very hard, pyriform with a longitudinal median groove and spot on the back, and two long curved pits on the front.*

Fig. 143. Privet, *Ligustrum vulgare*. 1, flowering shoot; 2, a flower, and 3, vertical section through it, enlarged; 4, fruit, and 5, section across the same; 6, seed (Wo).

Vitis vinifera, L. Vine (Fig. 142).

The Virginian Creeper, *Ampelopsis*, has similar, but smaller, and blue-black berries with no basal ring.

⊙⊙ *Seed* 1—2 *in the fruit, not marked thus; berry blue-black and smaller.*

Berberis Aquifolium, Ph. Mahonia.

†† No waxy bloom.

Ligustrum vulgare, L. Privet (Fig. 143).

(2) Fruits multiple or aggregate.**

Fig. 144. Blackberry, *Rubus fruticosus*. 1, flowering shoot; 2, vertical section of flower, slightly enlarged; 3, fruit, reduced; 4, floral diagram (Wo).

(a) **Fruit an æterio of drupels (syncarp) resulting from one flower, as shown by the calyx-remains at the base. Not milky.**

(i) Drupels with waxy bloom.

Rubus cæsius, L. Dewberry.

(ii) Drupels not covered with bloom.

Rubus fruticosus, L. Blackberry, Bramble (Fig. 144).

(b) **Fruit multiple, consisting of the results of numerous flowers on a head or in a hollow receptacle (anthocarp). Milky.**

Fig. 145. Mulberry, *Morus alba.* 1, a male, and 2, a female flowering shoot; 3, male, and 4, female flower, enlarged; 5, the latter in vertical section; 6, the multiple fruit (Wo).

(i) Anthocarp a head of false drupels, the flesh of each mainly derived from the perigone.

Morus alba, L. Mulberry (Fig. 145).

(ii) Anthocarp a syconus—i.e. a fleshy hollow receptacle, bearing numerous achenes on its inside.

Ficus Carica, L. Fig (Fig. 146).

Fig. 146. Fig, *Ficus Carica.* 1, flowering shoot; 2, female, and 3, male flower enlarged; 4, the fig in section, reduced (Wo).

APPENDIX*.

Capsule not very large, opening in three valves, and expelling about six black seeds :—

Fig. 147. Box, *Buxus sempervirens.* 1, flowering shoot; 2, a male, and 3, a female flower; 4, vertical section of latter; 5, ripe fruit opening; 6, carpellary walls; 7, seed. All but 1 enlarged (Wo).

Buxus sempervirens, L. Box (Fig. 147). The outer part of the pericarp separates from the endocarp and splits longitudinally down through the three styles and dorsal sutures, thus producing three two-horned valves. The endocarp in turn opens down six lines so suddenly as to fling forth the contained seeds. The capsule is an explosive one.

* Compare p. 93, under the paragraph (†).

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